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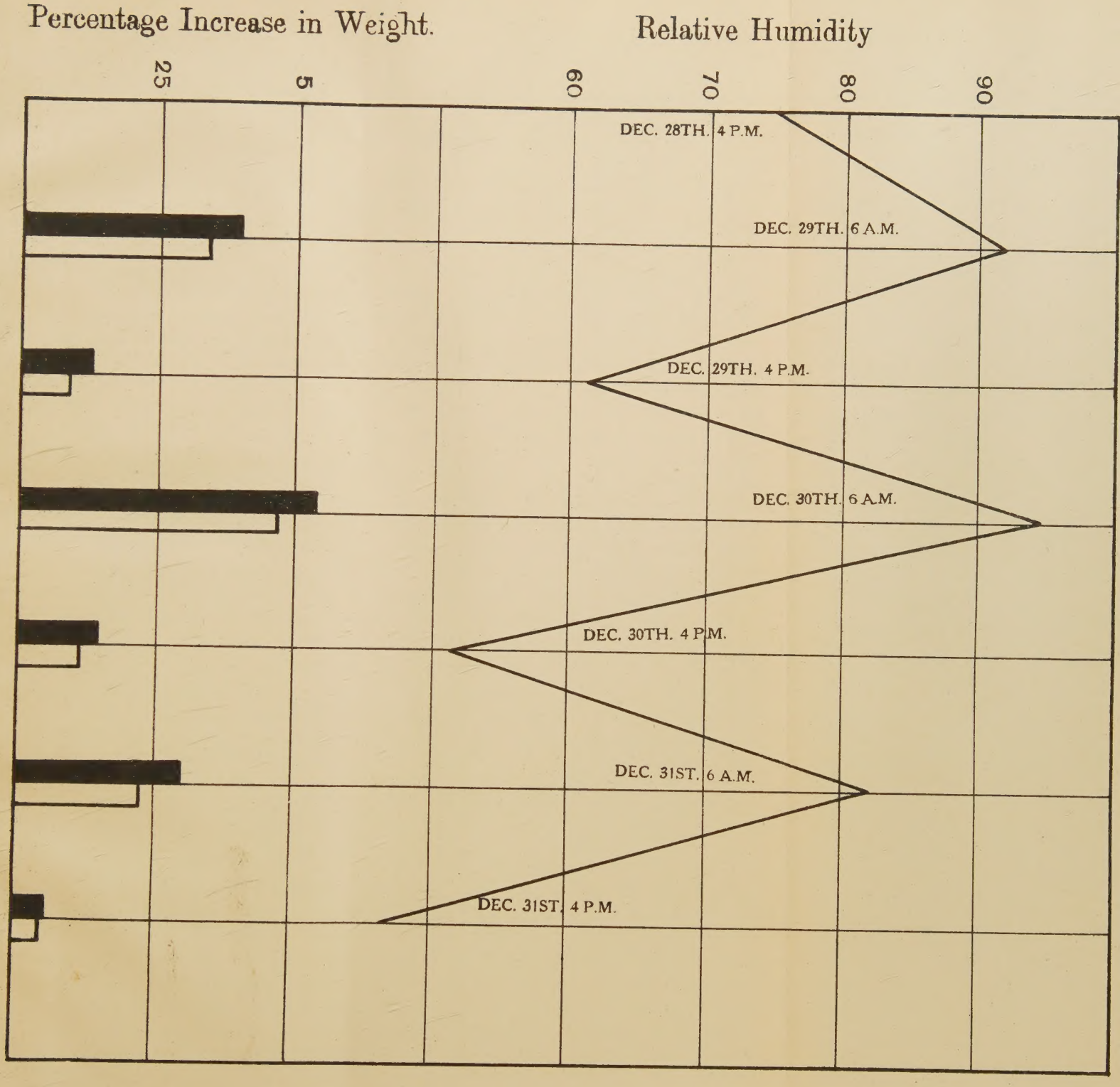
Percentage Increase in Weight.
Relative Humidity
25
5
60
70
80
90
DEC. 28TH. 4 P.M.
DEC. 29TH. 6 A.M.
DEC. 29TH. 4 P.M.
DEC. 30TH. 6 A.M.
DEC. 30TH. 4 P.M.
DEC. 31ST. 6 A.M.
DEC. 31ST. 4 P.M.

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AN INVESTIGATION OF THE CAUSES OF MOULDINESS OF CURED CACAO.

BY

T. LAYCOCK, A.R.C.SC., D.I.C.

The following account of some experiments designed to give information as to the causes of mouldiness of cured Cacao beans, will dissipate some erroneous ideas which have been held for a considerable time. The statement that unfermented beans are prone to mouldiness has been made repeatedly, but our experiments have shown that this is not the case. Dr. Oscar Loew (1) in his essay on "Fermentation of Cacao" states that "When pulped cacao is not "fermented but simply dried in the sun, the slimy layer around the "testa shrinks considerably but not to such insignificant thin films "as after fermentation. When the entire juice of the slimy layer "is simply dried up instead of being removed, a hygroscopic condition "of the product results, which in moist weather becomes sticky and "might support fungus growth." Again, Knapp (2) referring to the fact that fermentation is by no means universally practised states "Hence one finds on the market considerable quantities of cacao "which contain mouldy beans, for unfermented cacao readily goes "mouldy." Our experiments, outlined below, show that fermented beans mould much more readily than do the unfermented kind and that this tendency to mould is intimately bound up with the greater permeability to moisture of the husks of the former type of bean. It is generally admitted that the presence of moisture within the bean is the most important condition necessary to produce subsequent moulding, a fact of which this Department is fully cognisant, as instance the insistence in the Inspection of Produce Scheme that all grades of cocoa must be thoroughly dry.

Our first experiments were set up in order to determine whether there was any difference in the permeability of fermented and unfermented cacao beans. Weighed samples were placed in open petri dishes on the verandah and reweighed at 6 a.m. and 4 p.m. on four successive days and the relative humidity (determined by the wet and dry bulb thermometers) was ascertained at the same time. The results which are given in Chart No. 1 show very striking fluctuations in the amount of moisture reabsorbed, these fluctuations being correlated with the differences in relative humidity. The results show that under high conditions of humidity the beans

reabsorbed over five *per cent.* of moisture. It was noted also that fermented beans absorbed more than unfermented. The difference in permeability of the two kinds of beans, under ordinary atmospheric conditions, was hardly sufficient to account for the differences in the tendency to mould which we know obtains with fermented and unfermented beans, so other experiments were carried out under more humid conditions than those occurring naturally.

Five samples of beans were taken and after weighing were immersed in water for forty-five minutes. They were then dried off externally between blotting paper and weighed and the percentage increase in weight due to reabsorption of water was calculated. It will be noted from the results given in Table I that the fermented samples reabsorbed water to a much greater degree than did the unfermented sample.

TABLE I.

Cacao Sample.	Dry Weight.	Wet Weight.	% Increase in weight.
A. Unfermented ...	100 grams	121 grams	21
B. Fermented ...	100 „	136 „	36
C. Ripe Fermented ...	100 „	132·2 „	32·2
D. Unripe „ ...	100 „	134·5 „	34·5
E. Diseased „ ...	100 „	141·3 „	41·3

It was observed that the husks of cocoa beans become considerably swollen on immersing in water and an experiment to determine whether this portion of the bean was principally concerned with the reabsorption of water was carried out. A quantity of beans was shelled and the husks and nibs weighed. They were immersed in water for forty-five minutes, dried off between blotting paper and reweighed. The results tabulated in Table II below show that the husks take up most of the water. The same striking difference in the amount of moisture reabsorbed by the two kinds of beans is again apparent.

TABLE II.

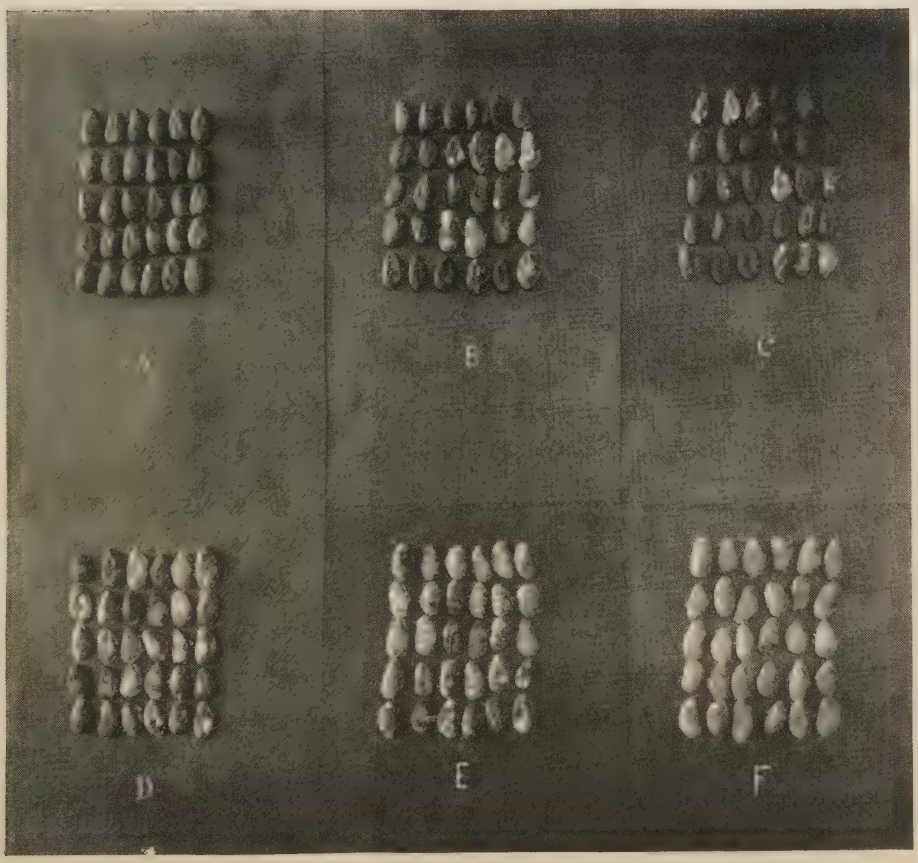
Sample.	Nibs.			Husk.		
	Dry Weight.	Wet Weight.	% Increase.	Dry Weight.	Wet Weight.	% Increase.
Unfermented	42·7	46·04	7·82	6·83	14·6	113·76
Fermented	41·1	47·7	16·05	8·05	25·2	213·04

(*Note.*—Only figures for two experiments are given in tables I and II but on repeating the experiments similar results were obtained).

PLATE I.

A. B.

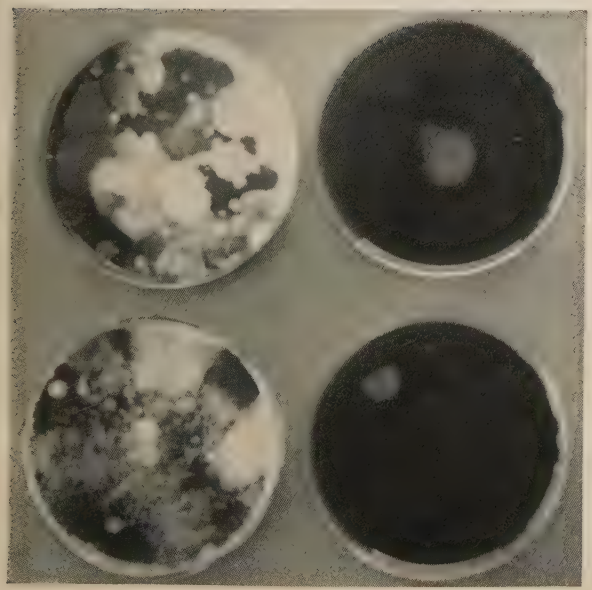
A.—Fermented beans (A) and unfermented beans (B).
Photographed after being four days in a damp chamber.



B.—Samples of fermented beans (A—F).
Photographed after immersion in water for 5, 10, 15, 20, 25 and 30 minutes respectively.

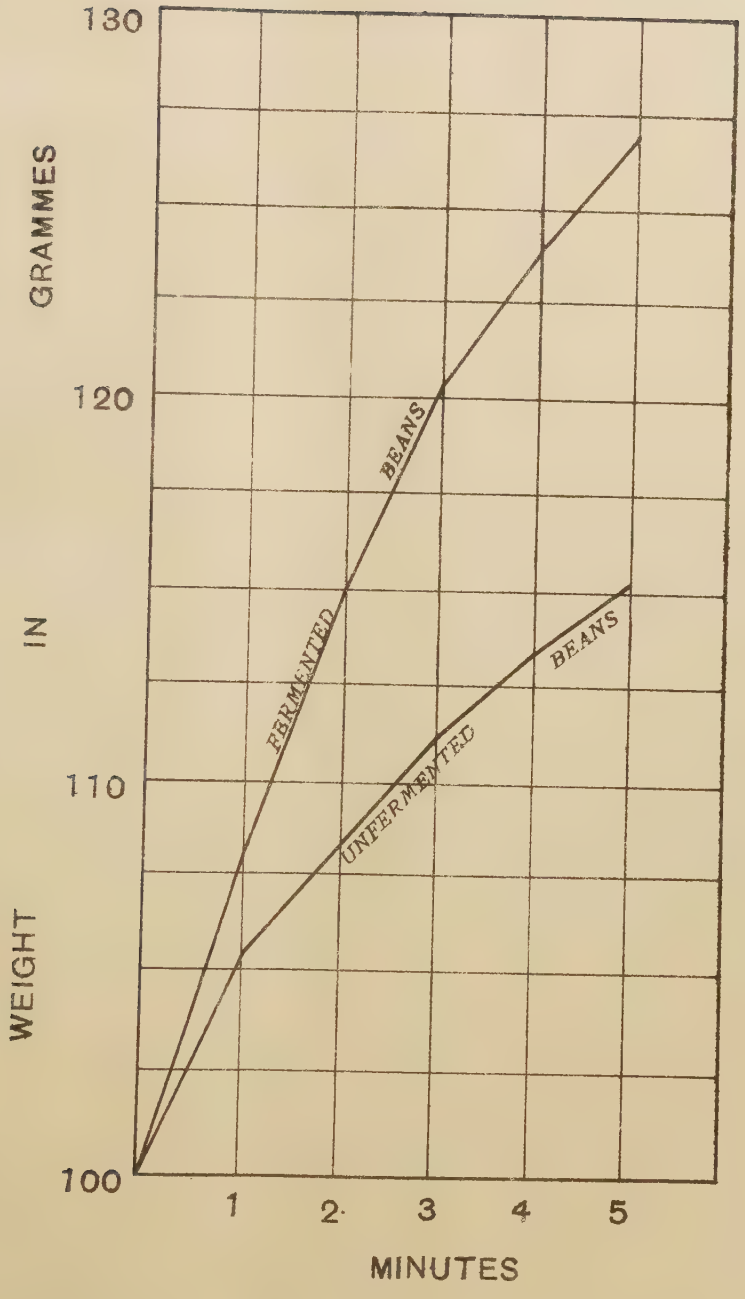
PLATE II.

A.—Two samples of beans which were sterilized externally and placed in damp air in toluene vacuum bath. Photographed after fourteen days.



B.—Mould colonies on culture media made from fermented cacao husks (left) and unfermented husks (right). Photograph taken seven days after exposure to air.

C.—Cultures of *Aspergillus* sp. on "fermented" media (left) and "unfermented" media (right). Two tubes of each medium. Photographed three days after inoculation.


130
120
110
100
GRAMMES
IN
WEIGHT
FERMENTED
BEANS
UNFERMENTED
BEANS
1
2
3
4
5
MINUTES

It was found that a concomitant of this greater permeability exhibited by the fermented beans was that they showed a greater proneness to mould than did the unfermented beans when subjected to the same treatment.

Other experiments, where the treatment was not so drastic as in those just described, were carried out in which the two kinds of beans were subjected to various degrees of humidity. In one experiment the beans were placed on copper gauze raised on a porous plate which latter was placed in contact with water, the whole being covered with a bell jar which was affixed to the porous plate by a coating of Canada balsam. The photograph shown in Plate 1A was taken after the beans had been under these conditions for five days and shows that whilst the fermented beans were badly moulded the unfermented were quite free. Other experiments were carried out under conditions which gave a definite degree of humidity, *e.g.*, in desiccators over ten *per cent.* caustic potash solution which by Wüllner's tables give a relative humidity of 94.2 at the ordinary laboratory temperature, also in vacuum desiccators over water, which were then evacuated so that one obtained 100 *per cent.* humidity. In all of these experiments we obtained the same results, *i.e.*, a greater reabsorption of moisture by the fermented beans with a concomitant greater degree of moulding.

Another experiment was carried out in order to obtain information as to the rate of reabsorption of water by fermented and unfermented beans after immersion. Weighed quantities of both types of bean were immersed for periods of one minute. They were then quickly dried off between blotting paper and reweighed. The results are given on Chart No. 2 and show that in five minutes the unfermented beans reabsorbed fifteen *per cent.* of water, whereas, in the same time, the fermented beans reabsorbed twenty-seven *per cent.*

The two samples were then placed under favourable natural conditions for drying and whereas the unfermented beans became completely dried out in three hours there was still 0.9 *per cent.* of moisture remaining in the fermented beans after drying for four and a half hours. The point of interest here is that the development of moulds depends not solely on the amount of reabsorbed moisture but also on the length of time such moisture is retained by the beans. The greater absorption of water by the fermented beans, if it should take place under conditions which retard a subsequent drying out, makes for a greater degree of mouldiness of the product.

It seemed reasonable to infer, assuming conditions were favourable for the retention of reabsorbed moisture, that the amount of subsequent moulding would be correlated with the amount of moisture taken up. To test this six weighed quantities of fermented beans were immersed in water for five, ten, fifteen, twenty, twenty-five and thirty minutes respectively. They were then dried off between blotting paper, reweighed and placed on covered plates. Table III shows the amount of water absorbed, and the amount of moulding which resulted three days after immersion is shown in the photograph Plate 1B. It will be seen that a correlation does obtain between the amount of water absorbed and the degree of mouldiness which resulted.

TABLE III.

Sample of Cacao.	Period of Immersion.	Percentage increase in weight.
A	5 minutes	10·42
B	10 ,,	17·21
C	15 ,,	21·05
D	20 ,,	22·10
E	25 ,,	26·08
F	30 ,,	29·15

The question now arose whether the greater proneness to moulding found in fermented beans is due entirely to their greater permeability to moisture. What would be the result if both types of cacao beans were allowed to take up the same amount of moisture? Two weighed samples, one of each kind of bean, were placed under the same conditions of humidity, the fermented sample being placed in dry air whenever it showed a greater percentage increase in weight than the unfermented sample. After four days the fermented beans had increased in weight 13.31 *per cent.* and the unfermented 13.24 *per cent.* and the former sample was badly moulded whereas the latter was only slightly affected. Thus the greater permeability of the fermented beans is not solely responsible for their subsequent greater degree of mouldiness.

It would appear very probable that the fermented product so readily moulds under humid conditions because of the access of fungus contaminations during the curing process, and an experiment was arranged to determine whether, in the absence of such contamination, this product would still support a greater growth of moulds than would the unfermented kind.

A sample of each kind of bean was sterilised by immersing in mercuric chloride solution (1-1000) for two minutes and was afterwards washed in distilled water and then dried off. These samples

were placed in a toluene vacuum oven which had been previously heated to 100°C for half an hour. Damp air (aspirated through water) was passed over the two samples for three hours daily. After fourteen days the fermented beans were completely moulded whereas the unfermented were free. The conditions of the experiment were such that there is little doubt that the growth observed was from air-borne spores, for with ordinary fermented beans the moulds appeared usually after four days under humid conditions and daily after this period the treated beans were taken out of the oven for observation purposes. The experiment shows, beyond doubt, that the fermented bean forms a more suitable pabulum for fungus development than does the unfermented. The great difference in the appearance of the two samples at the end of fourteen days is shown in the photograph Plate 2A.

Even when external contaminations, arising during the curing process, have been eliminated and even when the amount of moisture reabsorbed is kept about equal to that taken up by unfermented beans, fermented beans are found to mould much more readily than do the uncured ones, and it was thought that the hydrogen-ion concentration of both samples might be a factor responsible for the differences noted. Determinations were carried out and it was found that the husks of unfermented beans were much more acid than were those of the fermented—the pH value in the two cases being 3.4 and 4.8 respectively. The latter sample was five days fermented and it was also noted that beans which had been fermented for a longer period were more alkaline; a six-days fermented sample had pH 5.7 and seven-days fermented sample a pH of 5.8. Incidentally it is of interest to record that the permeability of fermented beans increases with a longer fermentation and we obtained the following percentage increases in weight after subjecting to a relative humidity of 94.2 for five days :—five-days fermented sample 8.13, six-days fermented sample 8.30 and seven-days fermented sample 8.65.

The pH value was determined by placing one gramme of husk in 20 ccs of distilled water, heating to boiling, filtering, and testing the filtrate—using the colour chart of Clark and Lubs. It should be mentioned that no correction was made for colour of solution but, as this did not vary greatly from one extract to another, the pH values are perfectly comparable although not necessarily quite correct. It was interesting to note that four days after carrying out the determination both the husks and filterate of the fermented sample showed a great growth of moulds whereas those from the unfermented were free.

Experiments were carried out in order to ascertain whether the greater proneness to mould exhibited by fermented beans was a concomitant of the hydrogen-ion concentration. Sterilised culture media made of extracts from the husks of both kinds of beans were found to have the same pH value as before. Series of petri dishes of both kinds of media were exposed to the air for five minutes and after a few days all the " fermented " were mouldy but only a few mould colonies appeared on the " unfermented " media. The striking difference in the degree of moulding is shown in Plate 2B. The experiment clearly established that the medium made from fermented beans was much more favourable for fungus growth than was that from unfermented. Various trial experiments were carried out before the pH value of both media was altered with significant results and these preliminary trials led to the following experiment. Four series of media were prepared the first two being untreated " fermented " and " unfermented " media respectively. The third series was from fermented husk extract which was acidified by N/10 hydrochloric acid to give a pH value of 3.4 which was the same as that of untreated " unfermented " media. In the fourth series made from unfermented husk extract the p H value was increased to 4.8 by the addition of N/10 sodium hydroxide. The pH in this case was made equal to that of the untreated " fermented " medium. Five petri dishes of each kind of medium were prepared and all were simultaneously exposed to air contamination for five minutes. The results, four days after exposure, are given in the following table.

TABLE IV.

No. of series.	Nature of Media.	p H value.	Number moulded	Remarks.
1	" Fermented " untreated.	4·8	5	Moulding commenced after two days and this series showed the greatest development.
2	" Unfermented " untreated.	3·4	0	No moulds appeared on this even after a period of six days,
3	" Fermented " treated.	3·4	4	Moulds started later here than in (4) but then developed faster.
4	" Unfermented " treated.	4·8	4	Slight moulding only.

The results in series (1) and (2) are similar to what were obtained in previous experiments. Series (3) and (4) although showing an equal number of plates producing moulds were yet strikingly different as regards the actual amount of fungus growth present. Thus although the treated " fermented " media showed a great growth in the end, the effect of the treatment was to inhibit the mould formation for a time. The growth in this was never so great as that in the untreated " fermented " series. Fungus growth started early in the treated " unfermented " media but then appeared to be inhibited and there was little development ultimately. Summarising the results of this experiment one can make the general statement that medium from fermented beans even though acidified was still more suitable for mould development than was that of unfermented beans which had been made alkaline and of the same p H value as ordinary fermented bean husks.

It would appear that the greater suitability for supporting the development of moulds which is exhibited by the husks of fermented beans is not merely a result of the greater p H value, as compared with that of the unfermented husks, but that in some way the chemical composition has some influence.

Pure cultures of species of *Aspergillus* were isolated from cacao beans and small quantities introduced into tubes of sterilised treated and untreated media from fermented and unfermented husks. The amount of fungus introduced was as far as possible equal in each case, whereas in the previous experiments when moulds were introduced from air-borne spores there could be no control of the amount which each plate received. The results, however, were very similar except that in this case the untreated " unfermented " medium did support a small amount of growth of the *Aspergillus* spp. Generally speaking the fermented, whether treated or untreated, had the greatest growth and the amount on the unfermented, whether treated or not, was small in comparison. The growth after three days on untreated " fermented " and " unfermented " media is shown in the photograph Plate 2C.

The experiments described in this paper show clearly that fermented cacao readily moulds if conditions are such as to produce a reabsorption of moisture. Whilst we have elucidated several causes which play a part in bringing about moulding it cannot be emphasised too strongly that during the fermentation and curing processes, as they are carried out on native farms in this country, the beans receive a large legacy of fungus infection. Some general considerations of these processes might conveniently be made at this point.

For normal fermentation, as Dr. Sack's experiments show (3) air must be admitted to the fermenting mass. At the same time if air has comparatively free access to the mass the conditions arise which are suitable for the development of moulds. It would seem that one should aim at an optimum amount of aeration which, whilst permitting normal fermentation, will at the same time reduce the formation of moulds to a minimum. Generally, one finds that small bulks of cacao beans in baskets or heaps mould more readily than do large bulks in boxes. In this latter case, the mass of beans attains a much higher temperature (as much as 46°C on the third day), than is the case with the smaller quantities. Mr. G. S. Hudson (4) states that in plantation practice the first lot of cacao to enter the fermenting houses is not as satisfactorily cured as are the later batches and he indicates that this is because, in the latter cases, the fermenting mass attains a temperature which defeats the mould. This may be true of some fungi but with one mould (*Aspergillus* sp.) which we isolated from cacao beans we found that it made much more vigorous growth at a temperature above 40°C than at the ordinary temperature within the laboratory (26-29°C). It seems very probable that the acidity of the fermenting mass plays a highly important part in keeping down the development of moulds. In a normal fermentation, during dry weather, we examined samples every day without observing any fungus hyphae, whereas on another occasion, when heavy rain had fallen whilst cacao was undergoing fermentation in the open, the bulk became very badly moulded. The access of water to the fermenting mass would have two effects, namely, it would reduce the acidity by washing away the watery pulp liquor around the beans and it would reduce the temperature. Probably the large degree of moulding in this case was the result of a combination of both these factors. The necessity for having fermenting boxes under cover in open sheds should be obvious.

The writer has had some experience of cacao production in the Cameroons and is in agreement with Hudson that the temperature within the fermenting mass plays an important part in the process. Thus a full bin of beans attains a higher temperature, (with a resultant superior fermentation) than does a half bin of beans. This fact is important when we consider our " co-operative scheme " for fermenting the cacao of the farmer as larger bulks are dealt with here than by individual farmers and hence better fermentation results with less risk of moulding.

If in a few years time it should be considered that fermentation of cacao is firmly established amongst the native farmers it would still be extremely beneficial if a real co-operative scheme of the farmers be continued in order that larger bulks of cacao may be dealt with in central fermentaries.

Assuming that a normal fermentation has taken place under ideal conditions such that no moulds are apparent, it is very rare that the drying process can be negotiated, in this country, without the product developing a certain amount of external moulding. Under the conditions obtaining in West Africa it is practically impossible to prevent this if sun drying is the only means adopted. In the Cameroons it is possible by artificial drying of the beans, or by a combination of artificial and sun drying, to obtain a product which is very free from external moulds. Even here it is necessary that the cacao should be dried off very rapidly during the first day after fermentation. If the moisture content of the beans is reduced to below fifteen *per cent.* (which is about ten *per cent.* in excess of the moisture content of air dried beans) one rarely finds moulds developing.

Our experiments indicate that it is imperative to dry very thoroughly during the first day of the curing process and to facilitate this the beans should be spread out in as thin a layer as possible and turned over repeatedly. The amount of fifteen *per cent.* moisture content which is stated to be a point up to which the beans will not mould appears to be quite correct, for we found that if air-dried beans (which contain about five *per cent.* moisture) had reabsorbed a further ten *per cent.* and were then allowed to dry out no moulding resulted. On the other hand if beans are kept under conditions which prevent the drying out of the moisture we have found that if only an additional five *per cent.* has been reabsorbed by air dried beans they will begin to mould after a time. In an experiment we placed a weighed quantity of beans in water for half a minute, dried them quickly between blotting paper and found that the percentage increase was 3.27. The beans were placed in a petri dish the cover of which was tightly packed with cotton wool which was kept moist with water. After ten days the beans were found to be slightly mouldy and on reweighing the percentage of moisture reabsorbed was found to be 5.08. We have already seen that if cacao beans are exposed to the air under conditions of high humidity that they will reabsorb over five *per cent.* of moisture. It is not surprising therefore that cured beans, apparently free of mould when dried, may become mouldy subsequently during storage.

We have found also, in both field and laboratory experiment, that in a mixed sample of cacao from the fermentation box, the unripe and diseased beans mould much more readily than do the ripe and healthy ones. The same result occurs if dried, unripe or diseased beans are allowed to reabsorb moisture. These results suggest that there should be a thorough grading of wet cacao in the field so that diseased or unripe beans may be cured separately.

The moulding which we have dealt with is purely external and would, if the product was kept perfectly dry, have little effect on the beans from the manufacturers' point of view. However, if such beans should be allowed to reabsorb moisture the fungi concerned would grow through the husks and infect the interior. In one experiment where beans were placed under conditions of high humidity (100 *per cent.* saturated atmosphere) the moulds had developed within the beans after an interval of two weeks. It will, therefore, be very obvious why it is so strongly stated, under our Inspection of Produce Scheme, that all grades of cacao should be thoroughly dry.

The question of storage of cacao is important and may be briefly considered at this point. There is no doubt that, even after bagging, cacao beans can reabsorb moisture when the relative humidity is high. On one cacao plantation in the Cameroons a parcel of cacao beans which had been dried under the writer's supervision and which had been quite free of mould when bagged was found to be slightly covered with mould when examined two months later. The husks of the beans which had previously been hard and brittle were now found to be soft and leathery and moisture was apparent on the nibs. The store was apparently dry, but the time was during the rains when the atmosphere was very humid. If cacao can reabsorb moisture under these conditions it will be readily understood that more moisture is likely to be reabsorbed by cacao stored in bulk in native houses. Cases are on record of perfectly good samples of cacao being held up by native producers in the hope of obtaining a better price and being entirely ruined by moulds as a consequence. The storage of cured cacao in this country should be for as short a period as possible and if the period of storage is unavoidably protracted the product should be inspected periodically and spread in the sun from time to time if any signs of moulds are apparent.

The greyish colour of certain samples of cacao, whilst indicating the presence of mould is not, of itself, a very serious defect and moreover there are methods of removing it, or at any rate making it non-apparent. Claying used to be resorted to in some countries but has now been abolished. Fresh lime juice sprinkled over the dried beans and danced well into the husk gives the latter a dark polished appearance which is apparently free of moulds and moreover the beans retain this appearance for a long time. We have treated beans immediately fermentation has been completed with three *per cent.* citric acid solution in one case and a half strength solution of fresh lime juice in another and afterwards

dried them in the ordinary way and the finished product was found to be quite free of moulds and to have a much superior appearance than had the untreated beans.

In conclusion we find that the fungi present on cacao beans are aerobic and are principally members of the genus *Aspergillus*. In a recent paper Ciferri (5) working on dried and fermented cacao bean in the Dominican Republic, states that a mouldy or musty odour was found on examination to be associated with the presence of five species of *Actinomycetes*. He also found that unfermented cacao beans yielded fewer actinomyces colonies than fermented ones (320 to 1230 per gramme of husk) which fact gives additional support to the conclusions reached in the present investigation.

Summary of Results.

(1) Fermented cacao beans mould much more readily than do unfermented under humid conditions.

(2) The fermented beans are more permeable to moisture than are unfermented and the husk is the part principally concerned in the reabsorption of moisture.

(3) The greater proneness to mouldiness of fermented cacao is not solely because of its greater permeability to moisture or to the presence of moulds arising during the curing process.

(4) The hydrogen-ion concentration of extracts from the husks of both types of beans has some bearing on the degree of mouldiness for if fermented husk extract is acidified we find that the development of moulds is inhibited and if unfermented husk extract is made more alkaline we get a greater growth of fungi than on the untreated husk extract.

(5) The difference in the chemical composition of the two kinds of husks probably plays an important part in determining the amount of subsequent moulding.

(6) There should be a thorough grading of cacao in the field as the presence of unripe and diseased beans result in (1) an increased development of mould, (2) an inferior discoloured cacao and (3) a possible source of moulding during subsequent storage.

(7) Fermentation should be carried out, preferably, in boxes and the larger the bulk of cacao treated the better will be the fermentation and the less the risk of mouldiness occurring. The boxes should be in open sheds to protect against rain.

(8) Every means should be taken to facilitate good drying during the initial stage.

(9) Storage of cured cacao in this country should be for as a short period as possible.

(10) The fungi isolated in this experiment are principally species of the genus *Aspergillus*.

ACKNOWLEDGMENT.

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A FIRST SURVEY OF INSECT AND FUNGOID INCIDENCE ON IMPROVED ISHAN COTTON.

BY

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Introduction.

The object of the present paper is to describe the results obtained from a survey of the factors affecting the development of indigenous cottons at Ilorin, Northern Nigeria, in the 1927-28 season.

In general the survey was of a similar nature to those conducted by a number of the research officers of the Nigerian Agricultural Department in past years (10; 1924) (12; 1925) (14; 1925), etc., but several new features both designed and adventitious characterised the investigations under review. For the first time a comprehensive study was undertaken of the pathogens affecting the improved strains of Ishan bred out by Lewin (8; 1927) and cotton intercropped with yams. The smallest infestation of cotton stainers (*Dysdercus* spp.) experienced in any survey and the discovery of several insect pests not previously recorded on cotton in Nigeria constituted the adventitious peculiarities of the present investigations.

OBJECTS OF THE EXPERIMENT.

The main objects were threefold, *viz.*:—

(*a*) A comparison of the factors affecting the development of the improved strains of Ishan and of the local Ilorin cotton: both grown alone and through yams.

(*b*) An investigation of the relation between pest incidence and time of flowering.

(*c*) A continuation of the study, initiated by Lean (7; 1927), of the late-flowering Kabba cotton.

Unfortunately the comparison of Ishan and Ilorin was somewhat vitiated by the utilisation of different methods of planting for the two species; a shortage of Ishan seed necessitated the use of Balls' sand sowing method (1; 1925), while the Ilorin cotton was planted in the ordinary manner, *viz.*, four or five seeds to a stand. The larger number of Ilorin seedlings obtained per stand allowed of a higher degree of selection during thinning operations with the result that, early in the season, the Ilorin plants were more vigorous than the Ishan. In addition, there was a considerable divergence in the number of plants obtained per acre probably partly for the same reason.

Plan of Work.

The following cottons were studied :—the sister strains A. and B. of Ishan (*Gossypium vitifolium*); Ilorin (*G. peruvianum*); Kabba (probably *G. vitifolium*) and, less extensively, Ishan strain E.

With the exception of Kabba sown on June 1st, all cottons were sown in the first week of July. Tenth-acre plots were utilised throughout the experiment and there was one plant per stand in all plots.

The main investigations were carried out on three contiguous plots of Ishan A., Ilorin and Ishan B. grown through yams in Block A., on three similar plots of these cottons grown alone in Block G. and on one plot of Kabba through yams in Block E.

Details of the planting distances, etc., in the various blocks are tabulated below.

TABLE No. 1.

Plot No.	"Variety."	Distance between ridges.	Distance between plants.	Total area of Block.	Previous cropping.	Remarks.
Main Investigations.						
A.34 A.35 A.36	Ishan A. Ilorin Ishan B.	5 feet ...	1½ feet ...	5 acres	1926. Maize and Guinea Corn. 1927. Yams	Grown through "Boki" yams.
G.49 G.50 G.51	Ishan A. Ilorin Ishan B.	6 „ ...	1½ „ ...	6¼ „	1926. Groundnuts and Mucuna. 1927. Mucuna.	Grown alone.
E.36	Kabba	6 „ ...	2 „ ...	7¼ „	1926. Cotton. 1927. Yams	Grown through "White Lisbon" yams.
Minor Investigations.						
H.20 H.21 H.22	Ishan A. Ilorin Ishan B.	6 „ ...	2 „ ...	5¾ „	1926. New land broken up; Mucuna	Grown alone.
G.53	Ishan E.	6 „ ...	1½ „ ...	6¼ „	*Vide* Block G. above	Grown alone.

On the main investigation plots, bud sheds were collected once a week, boll sheds on six days a week and mummied bolls twice a week; flowers were counted on six days a week.

On the minor investigation plots, mummied bolls were collected twice a week and flowers were counted once a week in H. 20 to 22 and on six days a week in G. 53. At the end of the season, the number of boll sheds was calculated by deducting the sum of mummied and harvested bolls from the total number of flowers produced.

Analyses of the damage to locks were made on ripe bolls from the main plots only.

Flower counting was terminated on February 11th; all flowers produced after that date were marked to enable the resultant bolls to be recognised.

It was found that a number of flowers (especially of Ishan A. and B.) did not open until after 9 a.m.—the time usually utilised for estimating flower production in cotton surveys. As the total number of boll sheds, mummies and harvested bolls on the main plots was known, at the conclusion of the investigations the total flowering figures for these plots were corrected; in three cases the error exceeded six *per cent.* Flowering in Block H. was also corrected on the assumption that the error for each cotton would be approximately the same on different blocks; no correction could be made for the solitary Ishan E. plot—G. 53.

Stainer Index.—Stainer infestation was estimated on Ishan A. and B., Ilorin and Kabba in the usual manner *vide* (2; 1925) and (6; 1927).

Bollworms.—Observations were made on the general and specific incidence, but no definite gauge could be undertaken as the time of the available staff was fully occupied in other directions.

Leaf Curl.—Mr. C. J. Lewin estimated the incidence of this disease on the quarter acre plots containing the main investigation units and has very kindly placed his results at the disposal of the writer. In addition the writer made Leaf Curl counts in Block E. for a special purpose described below—and in Block H.

Leaf Roller (Sylepta derogata, F.*) and Angular Leaf Spot.*—Periodic counts were made of the damage due to these causes.

Plant Counts.—The number of plants in each plot was determined in early September and, subsequently, at monthly intervals throughout the season. Moribund plants were uprooted and examined.

Rainfall.

In the following table are shown the average monthly and annual rainfall for the years 1905 to 1926 for comparison with the precipitation in the season under review.

TABLE No. 2.

Rainfall in inches.

Month.	Average 1905–1926.	1927–28.	Month.	Average 1905–1926.	1927–28.
April	4·58	*1927.* 5·68	October ...	6·37	*1927.* 9·98
May	6·60	9·44	November ...	1·40	1·92
June	7·28	8·24	December ...	0·38	0·38
July	5·85	4·41	January ...	0·13	*1928.* 1·62
August ...	4·76	2·89	February ...	0·81	0
September ...	10·42	7·24	March ...	1·86	5·99
Annual Rainfall	50·43	57·79	...	...	...

It will be seen that, while the September rainfall was 3.18 inches below the average for that month, the precipitation in the succeeding month was 3.61 inches in excess of the average for October This abnormality in the monthly distribution of rainfall would seem to be of considerable importance for, normally, the greatest concentration of rainfall occurs before the commencement of flowering. The rainfall in March was the highest ever recorded for that month at Ilorin.

Insect Incidence.

(a) Cotton Stainers:

As stated above the 1927-28 season was exceptional for the paucity of *Dysdercus* spp. The maximum migration occurred at the normal time for Ilorin (3; 1928), *viz.*, in the week ending October the 20th; but in the succeeding weeks very few stainers were taken

on the index plots, although they were found to be numerous on the seed heads of late bullrush millet only a few yards from the plots. In September, considerable numbers of adults and nymphs were seen feeding on the fruits of *Hibiscus esculentus*, *H. sabdariffa*, *Adansonia digitata* and *Urena lobata* within two miles of the Government farm, and it is difficult to assign a reason for their scarcity on the cotton in the succeeding months. It is perhaps significant that there has been a progressive diminution in stainer infestation—both on the Ilorin and Ibadan plantations—since the 1925-26 season after which only very small areas of Allen cotton have been grown.

In Table No. 3 is shown the number of adults collected from one-eighth acre of each variety of cotton in the present season and in 1926-27 (7; 1927).

TABLE No. 3.

Variety of Cotton.	Ilorin.	Kabba.	Ishan A.	Ishan B.	Unselected Ishan.
1927–28	194	22	89	44	...
1926–27	2,948	667	...	...	2,487

Very few nymphs were taken on the Ishans and Ilorin and none on the Kabba, so it is probable that the migrants remained on the cotton for a few days only; on the Ilorin plot 124 adults out of a total of 194 were collected in the week ending October the 20th. No rain fell between November the 3rd and December the 15th, and severe ' harmattan ' was experienced in the period November 6th to 11th; but, in spite of these adverse climatic conditions, a generation was observed to mature on the seed heads of late Bullrush Millet in the last week of November. The parents of this generation migrated shortly after oviposition had taken place.

From early January to the end of February stainers were almost entirely absent from the cotton.

(b) Other Rhynchota:

Although stainers were scarce a considerable amount of bug damage was noticed, especially on Ishan A. and B. from the end of December onwards. The following species of plant bugs were found to be attacking the bolls :—

Pentatomidae.

Nezara viridula, L.

Halydicoris scoruba, Dall.

Agonscelis versicolor, F.
Atelocera raptoria, Germ.

Coreidae.
Anoplocnemis curvipes, F.
Riptortus sp.

Of these only *N. viridula* has been previously recorded as a pest of cotton in Nigeria (6; 1927); this species and *H. scoruba* were seen in considerable numbers in February and March and from the data given elsewhere in this paper it will be seen that, in the present season, they attained to the status of major pests. Internal Boll Disease (*Nematospora* sp.) was not uncommon in spite of the scarcity of *Dysdercus* spp. and the question of its introduction into green bolls by other plant bugs would seem to merit investigation. Nowell (13; 1918) in the West Indies has shown that " the punctures of *N. viridula* readily cause infection with the fungi of Internal Boll Disease, but only when the bugs are transferred from infected plants."

Vayssière and Mimeur (15; 1926) have recorded *N. viridula* and *A. curvipes* as cotton pests in French West Africa. These authors make the following interesting statement about the habits of *N. viridula* " *Au Soudan, on rencontre cette Punaise sur les Cotonniers, surtout à l'état adulte et en fin de saison, lorsque la récolte du Sorgho est terminée et que les nombreuses Graminées de la brousse sur lesquelles elle se reproduit commencent à se dessécher. En effet, nous pensons que normalement N. viridula ne pond jamais sur le Cotonnier.*"

Only adults were seen by the writer on cotton at Ilorin, and it seems probable that *N. viridula* migrated from Gramineae in December; many Pentatomidae were seen feeding on the seed heads of Bullrush Millet in November.

A. curvipes was found to be breeding on the cotton in October.

Other plant bugs seen on the cotton, but not observed to be feeding on the bolls were :—

Pentatomidae.
Callidea natalensis, St.
Piezodorus pallescens, Germ.

Lygaeidae.
Lygaeus rivularis, Germ.
Aspilocoryphus fasciativentris, St.

(c) Bollworms:

During October and November, *Diparopsis castanea*, Hmps. was unquestionably the commonest bollworm, but in December—when bollworm infestation appeared to be at its maximum—*Earias biplaga*, Walk. and *E. insulana*, Boisd. were the predominant species; *D. castanea* larvae were not seen after that month. From January to March adults of *E. insulana* were frequently seen in the field and it is thought this species preponderated in this period. As shown later bollworm damage to mummies and harvested bolls (and, usually, to boll sheds) was greater in the present investigations than in any previous survey of the factors affecting the development of indigenous cottons.

Argyroploce leucotreta, Meyr. was responsible for considerable damage to Tangerines on the Government farm in September, the affected fruits being abscissed before the pupation of the larvae took place. On the writer's recommendation the shed fruits were deeply buried; few of these bollworms were found later on the cotton.

(d) Jassids (Empoasca facialis, Jac.):

In October jassids were abundant in Block G.—where the soil was of poor quality—adjacent to the site of the Ishan plot which was almost entirely destroyed by this pest in 1926 (7; 1927). On November 6th it was found that, whereas the foliage of Ilorin and Ishan E. had been seriously affected, that of Ishan A. and B. was but little damaged. It was also possible to differentiate between the two groups by walking through the plots and observing the Jassid population, which was very noticeably smaller on Ishan A. and B. than on Ishan E. and Ilorin. It would appear that the pubescence on the leaves of A. and B. is responsible for a marked degree of immunity to Jassids.

(e) Leaf Roller (Sylepta derogata, F.*):*

In the latter half of October from 9.8 to fifty-six *per cent.* of the plants in the Ishan A. and B. plots were attacked by this pest, while only from 2.2 to four *per cent.* of the Ilorin plants were affected. In the succeeding month the pest was checked by hymenopterous parasites.

(f) Helopeltis spp. were very rare.

Incidence of Fungoid and Virus Diseases.

(a) Leaf Curl:

In Table No. 4 is shown the percentage of plants affected by leaf curl at monthly intervals up to the end of December.

TABLE No. 4.

Percentage of Plants affected by Leaf Curl.

Plot No. Variety.	A.34 Ishan A.	A.35 Ilorin.	A.36 Ishan B.	A.38 Ishan E.	G.49 Ishan A.	G.50 Ilorin.	G.51 Ishan B.	G.53 Ishan E.	E.36 Kabba.
1927.									
Sept. 10th ...	2·3	7·4	3·5	18·8	0·2	1·1	0·5	1·5	35·7
Oct. 8th ...	6·3	25·8	8·8	56·3	0·2	2·6	0·6	6·2	47·3
Nov. 5th ...	9·7	38·9	15·9	77·3	0·5	6·4	0·7	14·2	52·3
Dec. 3rd ...	11·3	40·2	16·7	77·8	0·5	9·2	0·7	18·7	53·4
„ 31st ...	11·6	40·2	16·7	78·2	0·5	9·6	0·7	18·8	53·7

These interesting figures of Mr. Lewin's confirm his previous observations on the resistance of Ishan A. and B. to leaf curl (9; 1927) The high initial degree of infection on the Kabba plot was probably due to the earliness of planting, *viz.*, June 1st, as atmospheric conditions in June are favourable for the insects, Aleurodidae, thought to be vectors of this virus disease. Leaf curl counts were made by the writer on a number of plots of all varieties in Block E. to determine if the infection was high early in the season as a result of proximity to the early-sown Kabba. The percentage infection figures shown in Table No. 5 suggest that this was the case.

TABLE No. 5.

Plot No. Variety.	E.32 Ishan B.	E.34. Ishan E.	E.35 Ilorin.	E.37 Ilorin.	E.38 Ishan A.
September 10th	9·6	No record	* 47·2	25·9	5·5
October 19th	10·5	72·2	* 40·1	37·9	5·5

* Error due to variable methods of assessment by independent observers; figures included to show high degree of early infection.

In Block H, the infection percentages on November 23rd were as follows:—

Ishan A., 0; Ilorin, 1.6; and Ishan B., 0.3.

(b) Bacterial Disease:

During October, November and early December, angular leaf spot and black-arm were responsible for much damage to the foliage and plant body respectively, while bacterial lesions on the bolls were the chief cause of abscission and mummification in Block G. None of the varieties grown through yams in Block A. suffered to as great

an extent. On September 29th and 30th, counts were made of the number of plants showing signs of angular leaf spot infection in the various blocks; although only from five to sixteen *per cent.* fewer plants were found to be infected in cotton through yams than in cotton grown alone, the degree of infection was very markedly less in the former series of plots than in the latter.

Similarly, an area of Ishan B. through yams in Block H. was less severely attacked than the same variety of cotton grown alone in a neighbouring plot. It is suggested that the yam foliage operates as a screen, to some extent, against rain-borne infection.

(c) Alternaria:

This disease was more prevalent in Block G. than in Block A.; but was only of importance as a boll-shedding agent on the earliest-flowering cotton, viz., Ilorin in the first-mentioned block.

(d) Anthracnose and Diplodia:

Neither of these diseases was prevalent.

Plant Counts.

In Table No. 6 are shown the number of plants per acre on September 6th, the percentage of plants which died in the succeeding six months and the percentage stand obtained.

TABLE No. 6.

Plot No. Variety.	A.34 Ishan A.	A.35 Ilorin.	A.36 Ishan B.	G.49 Ishan A.	G.50 Ilorin.	G.51 Ishan B.	G.53 Ishan E.	E.36 Kabba.	H.20 Ishan A.	H.21 Ilorin.	H.22 Ishan B.
No. of plants per acre on September 6th	4,070	4,940	4,120	3,930	4,750	4,200	3,830	3,170	2,810	3,130	3,210
% stand obtained	68	83	69	81	98	87	79	90	80	89	91
% loss up to March 6th ...	2·2	8·7	2·9	0·8	8·8	2·6	8·6	3·2	2·8	2·6	1·6

In the Blocks A. and G. there was a considerable discrepancy in the number of plants per acre of Ilorin and Ishan, probably partly as a result of the different methods of planting employed for the two species. The majority of moribund plants showed signs either of root damage by larvae of *Syagrus calcaratus*, F. or of stem damage by Buprestid larvae (prabably of *Pseudagrilus sophorae*, F.); many of the dying plants in Block A. were also severely affected by leaf curl. It is thought that Jassid attack may have been a cause of death in plots G. 50 and 53.

Bud-Shedding.

The total number of bud sheds, the percentage of sheds without lesions and the percentage attacked by bollworms and bacteria are shown in Table No. 7.

TABLE No. 7.

Plot No.	Variety of Cotton.	Total No. buds shed per acre.	% without lesions.	% attacked by :—	
				Bollworms.	Bacteria.
A.34	Ishan A. ...	80,710	53	32	8
A.35	Ilorin ...	74,900	53	30	4
A.36	Ishan B. ...	79,660	46	45	6
G.49	Ishan A. ...	93,240	58	13	20
G.50	Ilorin ...	99,400	64	5	15
G.51	Ishan B. ...	92,050	57	10	23
E.36	Kabba ...	40,320	72	8	9

It will be seen that there are decided differences in the proportions of bud sheds bearing bollworm and bacterial lesions in Blocks A. and G. The cotton through yams in Block A. was from three to four weeks later in flowering than that in Block G. (in the case of each variety) and it is evident that the time factor was partly responsible for the variations demonstrated in Table No. 6. Maximum bud production in Block G. coincided with the period of prevalence of bacterial disease and in Block A. with heavy bollworm infestation.

The yams in Block A. were harvested on November 17th; but in Block E. the White Lisbon yams were attacked by a very serious fungoid disease in August and it was necessary to remove the vines on September 3rd. It would seem probable that the retarding effect of the yams on the growth of the Kabba would not be pronounced, yet, although sown thirty days earlier than in the previous season, it commenced to flower thirteen days later. Mason and Maskell (11; 1927) have stated that certain native cottons in West Africa are "characterised by the fact that if planted during the rains they "continue to shed their flower buds until the advent of the dry "season." The Kabba only commenced to shed flower buds on September 20th, and the retardation of flower production appears to have been due rather to retarded growth of the plants than to the shedding of flower buds. The early sowing of Kabba had no beneficial results and was probably responsible for the heavy leaf curl infection in September.

Flower Production.

The importance of late-flowering as a means of avoiding heavy stainer infestation has been stressed in several previous papers. (2; 1925), (7; 1927), (4; 1928). The paucity of *Dysdercus* prevented additional evidence on this point being obtained in the present investigations; but it has been possible to throw some light on the relationship between bollworm and bacterial incidence and time of flowering.

Lewin (*see* Golding and Lean, 5; 1927) has described the flowering of Ishan A. at Ibadan as late and of Ishan B. as very late; at Ilorin, Ishan B. was slightly earlier than A. in its flower production, while at Ibadan this year Lewin has again found the reverse to be the case.

The total number of flowers produced up to February 11th and the week of maximum flower production (for the primary flowering cycle) are tabulated below.

TABLE No. 8.

Plot No.	Variety of Cotton.	Total No. flowers produced per acre.	Week of maximum flowering primary cycle.
			Week ending:—
A.34	Ishan A. In yams ...	139,080	December 10th.
A.35	Ilorin „ „ ...	140,250	November 19th.
A.36	Ishan B. „ „ ...	120,490	December 10th.
G.49	Ishan A. Alone ...	171,290	November 19th.
G.50	Ilorin „ ...	113,020	October 22nd.
G.51	Ishan B. „ ...	154,140	November 12th.
G.53	Ishan E. „ ...	122,960	October 22nd.
E.36	Kabba. In yams ...	47,840	December 10th.

Ishan A. and B. are about three weeks later than Ilorin, Ishan E. corresponds closely to Ilorin, while the effect of planting cotton through yams is to retard flowering for a period of from three to four weeks. It will be seen that Ishan A. and B. through yams are as much as seven weeks later in their flowering than Ilorin cotton grown alone. It is obvious that the inter-cropping of cotton with yams—the common practice in the Ilorin Province—exposes the cotton to an entirely different set of conditions through the retardation of flower production; this question is discussed in a later section of the present paper.

Total flower production compares very unfavourably with the figures obtained by Lean in the previous season (7; 1927), *viz.*, Ishan (unselected) 344,700; Ilorin 218,500 and Kabba 92,100. The low flower production may have been the result of poor quality of soil as bud shedding was actually less extensive in the investigations under review. Lean has described the soil in Block B.—the site of his native cotton plots—as being good, while the writer would hesitate to use a similar description for the soil of any the blocks utilised in the present season.

Flower and Boll-Shedding.

The combined loss of bolls through abscission and mummification was exceptionally great for native cottons and was chiefly due to the prevalence of bacterial disease, bollworms and plant bugs.

The total percentage of flowers and bolls shed and the proportions of sheds bearing lesions of the various inhibiting factors are shown in Table No. 9.

TABLE No. 9.

Plot No. Variety.	A. 34 Ishan A.	A.35 Ilorin.	A.36 Ishan B.	G.49 Ishan A.	G·50 Ilorin	G.51 Ishan B.	E.36 B.Kabba
Total % shed	53	38	53	63	46	60	34
% attacked by boll-worms	46	40·5	38	24	16	23	37
% attacked by bugs ...	18	7	21·5	17	9	16	14
% attacked by bacteria	13	7·5	13·5	24	27	23	11·5
% attacked by *Alternaria*	0	1	0	1	13	2	2·5
% without lesions ...	6	19	9	10	12	11	10
% unclassified	17	25	18	24	23	25	25

Sheds which bore bacterial lesions on the epicalyx only were included in the unclassified group, which is unusually large for this reason. In every case sheds diagnosed as being attacked by bacteria bore characteristic lesions on the pericarp or at base of calyx.

The high percentage of sheds attacked by *Alternaria* on G. 50. Ilorin is of interest; it will be remembered that this was the earliest flowering plot. As in the case of bud-shedding (*vide* Table No. 7), bollworm damage was greater in the late-flowering cotton through yams than in cotton grown alone, while the reverse was true of bacterial damage. Under both sets of conditions Ilorin had a markedly smaller proportion of sheds attacked by bugs than had either Ishan A. or B.

Mummied Bolls.

The total percentage of bolls mummied and the relative importance of the factors responsible for mummification are shown in Table No. 10.

TABLE No. 10.

Plot No. Variety.	A.34 Ishan A.	A.35 Ilorin.	A.36 Ishan B.	G.49 Ishan A.	G.50 Ilorin.	G.51 Ishan B.	E.36 Kabba.	H.20 Ishan A.	H.21 Ilorin	H.22 Ishan B.
Total % mummied	15	16	15	15·5	22	17·5	12	12	17	15
% attacked by :—										
Bollworms ...	21	50	24	33	24	31	45	37	36	37
Bugs	51	14	48	24	8	24	15·5	34	12	31
Bacteria ...	6	10	5	15	40	17	4·5	16	33	15
% unclassified ...	22	26	23	28	28	28	35	13	19	17

The total percentage of bolls mummied is considerably in excess of the corresponding figures obtained in previous surveys; in the opinion of the writer the mummification of bolls is usually the direct result of insect or fungoid attack: the excessive mummification, noted in the present investigations, was concurrent with an unusually abundance of major pests.

It is of interest to note that, as was the case with boll sheds, a smaller proportion of mummies bore bug punctures on the Ilorin plots than on the Ishan.

Harvested Bolls.

The results of lock analyses are shown in Table No. 11; the harvesting period has been divided into three periods to demonstrate the relative importance of the various pathogens at different times and to show the incidence of ripe boll production on early and late-flowering cottons.

TABLE No. 11.

A. 34. Ishan A.

Period ending :—	No. of bolls harvested.	% Undamaged.	% Damaged by :—			% Unclassified.	Weight of seed cotton.		% Stained.
			Bollworm.	Bugs.	Bacteria.		lb.	oz.	
January 7th ...	5,010	49	22 (6)	12 (3)	14 (1)	3	15	0	32
February 18th ...	22,380	25	30 (9)	24 (5)	14 (1)	7	55	0	42
March 31st ...	17,610	20	29 (7)	41 (9)	8 (2)	2	44	13½	50·5
Totals	45,000	26	29 (8)	30 (6)	11 (1)	4	114	13½	44

TABLE No. 11—*continued.*

A. 35. Ilorin.

Period ending :—	No. of bolls harvested	% Undamaged.	% Damaged by :— Bollworm.	Bugs.	Bacteria.	% Unclassified.	Weight of seed cotton.		% Stained.
January 7th ...	26,460	24	27 (10)	8 (2)	35 (7)	6	88	7	43
February 18th ...	29,910	21	30 (10)	12 (3)	28 (5)	9	80	10	52
March 31st	8,020	20	32 (16)	27 (13)	15 (4)	6	19	11	60
Totals	64,390	22	29 (11)	12 (4)	30 (6)	7	188	12	49

A. 36. Ishan B.

January 7th ...	5,470	44	21 (6)	12 (3)	16 (1)	7	17	3	33
February 18th ...	20,060	28	29 (8)	23 (6)	13 (1)	7	45	10	42
March 31st	12,660	23	26 (11)	40 (12)	9 (2)	2	32	10½	50·5
Totals	38,190	28	27 (9)	27 (7)	12 (2)	6	95	7½	44

G. 49. Ishan A.

January 7th ...	13,140	29	36 (9)	16 (3)	15 (3)	4	37	13	40
February 18th ...	13,620	27	41 (12)	17 (2)	11 (2)	4	32	3	49
March 31st	9,400	39	32 (6)	16 (5)	10 (3)	3	26	9	31·5
Totals	36,160	31	37 (9)	16 (3)	12 (2)	4	96	9	41

G. 50. Ilorin.

January 7th ...	13,670	18	26 (10)	14 (1)	40 (10)	2	40	10	63
February 18th ...	5,160	14	59 (21)	6 (2)	18 (3)	3	12	10½	61
March 31st	17,720	29	46 (10)	9 (2)	15 (3)	1	54	3½	52
Totals	36,550	23	40 (11)	10 (2)	25 (6)	2	107	8	59

G. 51. Ishan B.

January 7th ...	12,490	36	28 (6)	12 (2)	23 (3)	1	32	3	38
February 18th ...	11,360	27	42 (10)	17 (6)	11 (2)	3	24	11	45
March 31st	10,800	37	39 (7)	17 (5)	6 (2)	1	29	1	32
Totals	34,650	33	36 (8)	15 (4)	14 (2)	2	85	15	39

E. 36. Kabba.

January 7th ...	1,080	28	37 (14)	9 (3)	21 (6)	5	2	13	44·5
February 18th ...	3,390	21	58 (18)	7 (2)	12 (1)	2	9	6	50
March 31st	21,570	43	25 (6)	24 (6)	6 (1)	2	71	6½	30
Totals	26,040	40	30 (8)	21 (5)	7 (1)	2	83	9½	32·5

The figures in brackets represent the percentage of locks rendered useless by the various factors.. these are included in the preceding total damage percentages.

It will be seen that while the seed cotton produced in Block A. became more stained as the season advanced, the crop harvested in Block G. during the final period was cleaner than in either of the two preceding periods. In previous surveys the late pickings have yielded the cleanest cotton; the heavy infestation of plant bugs in Block A. during January, February and March was the primary cause of the augmentation of staining in the last two periods. It will be realised that this factor is of paramount importance, for, while late-flowering cottons escape stainer attack to a large extent, they are more exposed to plant bug damage than are early-flowering varieties. It is possible that the abundance of plant bugs in the season under review was abnormal, and the fact that these insects have not been recorded as pests in past seasons supports this view. On the other hand, their decided preference for the selected Ishans A. and B., which have not been surveyed before, needs further investigation as their unusual prevalence may conceivably have been correlated with the initiation of the growing of selected Ishan on a plantation scale at Ilorin.

There was little difference in bollworm damage to locks of the various cottons, but both Ishans A. and B. suffered less than Ilorin from bacterial attack; it will be remembered that similar observations were made in the case of mummied bolls, *vide* Table No. 10. There were no significant differences in disease incidence on Ishans A. and B.

Generally speaking, bacterial incidence was at its maximum in the first period, bollworm in the second and bug in the third; the crop from cotton through yams was cleaner than that from cotton grown alone for the first two periods, and, but for the unexpected appearance of plant bugs as major pests, would undoubtedly have been less stained in the final period also. It must be remembered that the retarded flowering due to intercropping would have been distinctly advantageous if *Dysdercus* had been prevalent. Bud production on cotton through yams was later than in cotton grown alone; the retardation of flowering due to competition with the yam crop is correlated with delayed growth of the plant and not with the shedding of buds produced early in the season.

Comparison of Ilorin and Selected Ishans.

Before discussing the question of yields, the writer would like to emphasise the fact that his conclusions are not based on the crop obtained from the tenth-acre special plots, but on that from the main blocks containing these plots. A very obvious disadvantage of surveys of the present type is that, owing to the time and labour

necessary for the accumulation of flowering and shedding data, etc., it is impracticable to utilise a large number of plots of each variety under investigation. There is a danger that atypical results might be obtained; the writer kept the non-experimental parts of the blocks under observation and could detect no significant differences in insect or fungoid incidence on the two areas. Soil variation would appear to be of greater importance in the question of yield, and in Table No. 12 are shown the yields from the special plots and the average crop for each cotton in the main variety tests.

TABLE No. 12.

YIELDS IN LB. SEED COTTON PER ACRE.

Block.	Variety.	Yield as obtained in :—	
		Farm variety Test.	Special Survey.
A.	Ishan A.	114	115
A.	Ilorin	158	189
A.	Ishan B.	96	95
G.	Ishan A.	89	97
G.	Ilorin	127	107
G.	Ishan B.	76	86
G.	Ishan E.	50	58
H.	Ishan A.	91	76
H.	Ilorin	137	172
H.	Ishan B.	98	81
E.	Kabba	78	84

It will be seen that the relative positions of all varieties are similar in both sets of results.

TABLE No. 13.

	No. of Plot. Variety of Cotton.	A.34 Ishan A.	A.35 Ilorin.	A.36 Ishan B.	G.49 Ishan A.	G.50 Ilorin.	G.51 Ishan B.	E.36 Kabba.
Flower Buds.	Total No. per acre	219,790	215,150	200,150	264,530	212,420	246,190	88,160
	„ % Shed	37	35	40	35	47	37	46
	„ % attacked by Bollworms ...	12	10	18	5	3	3	4
	„ % „ „ Bacteria ..	3	1	3	7	7	9	4
	„ % without lesions	20	19	18	20	30	22	33
	„ % unclassified	2	5	1	3	7	3	5
Flowers and Bolls.	Total No. Flowers per acre	139,080	140,250	120,490	171,290	113,020	154,140	47,840
	„ % Shed	53	38	53	63	46	60	34
	„ % attacked by Bollworms ...	25	15	20	15	7	14	12
	„ % „ „ Bugs	9	3	11	10	4	10	5
	„ % „ „ Bacteria ...	7	3	7	15	12	14	4
	„ % „ „ *Alternaria* ...	0·1	0·3	0·1	0·4	6	1	0·8
	„ % without lesions ...	3	7	5	6	6	6	3
	„ % unclassified	9	10	9	16	11	15	9
Mummied Bolls.	Total % Bolls mummied per acre ...	15	16	15	15·5	22	17·5	12
	„ % attacked by Bollworms ...	3	8	4	5	5	5·5	5
	„ % „ „ Bugs	8	2	7	4	2	4	2
	„ % „ „ Bacteria ...	1	2	1	2	9	3	1
	„ % unclassified	3	4	3	4	6	5	4
Harvested Bolls.	Total No. Bolls harvested per acre ...	45,000	64,390	38,190	36,160	36,550	34,650	26,040
	„ % Locks undamaged	26	22·5	28·5	31	23	33	40
	„ % „ damaged by Bollworms ...	28·5	29	27	37	40	36	30
	„ % „ „ „ Bugs ...	30	12	27	16	10	15	21·5
	„ % „ „ „ Bacteria ...	11·5	29·5	12	12	25	14	7
	„ % „ unclassified	4	7	5·5	4	2	2	1·5
Seed Cotton.	Yield per acre in lb. Seed Cotton ...	115	189	95	97	107·5	86	84
	„ % Seed Cotton stained	44	49	44	41	59	39	32·5

TABLE No. 14.

Plot No. Variety of Cotton.	H.20 Ishan A.	H.21 Ilorin.	H.22 Ishan B.	G.53 Ishan E.
Total No. Flowers per acre ...	118,240	132,420	134,140	122,960
% Shed	64	43	62	70
% Bolls mummied	12	17	15	12
Total No. Bolls harvested per acre	28,650	51,790	30,510	22,360
Yield per acre in lb.	76	172	81	58
% Seed Cotton stained	46	56	43	36

The results of the survey are summarised in Tables Nos. 13 and 14; when comparing the yields the following considerations should be borne in mind : the smaller stands of Ishans in Blocks A. and G. (*see* Table No. 6), the initial disadvantages suffered by the Ishans as a result of diverse planting methods, the lower percentage of stained seed cotton on the Ishan plots and the considerably higher value of the Ishan lint. Another factor to be considered is the earlier flowering of the Ilorin cotton which attracted pests to the plots before the Ishans commenced to flower, and thereby probably augmented the damage to Ishan at the commencement of flower production.

Ishans A. and B. exhibited marked resistance to leaf curl and jassids, and suffered less from angular leaf spot and bacterial boll rots than Ilorin, but were subject to greater damage from plant bugs and the minor pest, *Sylepta derogata*, F.

Ishan E. gave the poorest yield, suffered much from jassid attack and was less resistant to leaf curl than was Ilorin.

Ishan A. gave a higher yield than Ishan B. in Blocks A. and G. and yielded only five pounds per acre less in H.20, than in H.22, in spite of there being over twelve *per cent.* fewer plants of A. than B. In addition, Ishan A. possesses a greater degree of resistance to leaf curl.

Observations on the Characters of Kabba Cotton.

Lean (7; 1927) attributed some importance to the high loculus number of Kabba, *viz.*, an average of 3.20 compared to 3.06 for unselected Ishan; in the present experiment this figure for Kabba was 3.16 for Ishan A., 3.12 and for Ishan B., 3.06.

A ten acre plot of Kabba in Block A. suffered very severely from leaf curl, jassids and black arm and the plants were almost entirely defoliated; but they exhibited very surprising powers of recovery and produced an abundance of new foliage.

Apart from its susceptibility to leaf curl, it is evident that Kabba is too late in its flowering to be grown in the Ilorin Province, where cotton is normally sown through yams. Although this vigorous, deep-rooted cotton is well able to withstand competition with the soil-exhausting yam crop, the retardation of the flowering of an already very late-flowering cotton results in the bulk of the crop being produced too late to be of any practical value. As stated by Lean a selected strain might be of much value, but it would be necessary to obtain a strain with some resistance to leaf curl and less late in its flower production. It must be remembered that the Kabba in Block E. would probably have been even later in its flowering if the yam vines had not been removed in early September.

Summary and Conclusions.

1. A survey has been made of the factors affecting the development of improved Ishan A. and B., and Ilorin—both grown through yams and alone—and of Kabba intercropped with yams. With the exception of Kabba—sown on June 1st—all cottons were sown in the first week of July.

2. The 1927-28 season was peculiar for a remarkably small infestation of cotton stainers; the amount of damage done to the crop by plant bugs—most of which had not been previously recorded as cotton pests in Nigeria; and finally the prevalence of bollworms, bacterial disease, jassids and leaf curl.

3. It was found that the flowering of Ishan A. and B. was about three weeks later than that of Ilorin; also that the flowering of many variety of cotton grown through yams was about three weeks later than that of the same variety grown alone.

Except for the last six weeks of harvesting, the crop from cotton through yams was cleaner than that from cotton grown alone; plant bugs were chiefly responsible for the greater degree of staining on the first-mentioned plots late in the season. These bugs appeared to prefer Ishan A. and B. to Ilorin, and are of considerable importance; it is not yet certain whether their abundance in the present season was abnormal or whether they were attracted by the planting of selected Ishan on a considerable scale for the first time.

4. The yield of Ilorin exceeded those of the Ishan strains, but the Ishan seed cotton was cleaner and is of considerably greater value; in addition there were usually fewer Ishan plants per acre and a different method of planting—employed for the two species—placed the Ishan at a distinct disadvantage. Boll shedding and mummification were unusually extensive, apparently as a result of the prevalence of major pests; the loss from these causes was from ten to seventeen *per cent.* greater in the case of the Ishans than in that of Ilorin.

5. The Ishan strains A. and B. are markedly resistant to leaf curl and jassids and, owing to their later flowering, would be less exposed to damage from stainers than Ilorin. If the plant bug infestation late in the season was abnormal, it seems probable that their yield will more closely approximate that of Ilorin in a normal year.

6. Ishan A. gave a higher yield than Ishan B. and is more resistant to leaf curl. Ishan E. gave a very poor yield and is highly susceptible to both leaf curl and jassid attack.

7. Kabba is susceptible to leaf curl and jassids and is so late in its flowering that, when grown through yams, the bulk of its crop would not ripen before the end of March. The possibility of the production by seed selection of an earlier flowering strain with some resistance to leaf curl and jassids would seem to merit attention.

Acknowledgments.

In conclusion, the writer wishes to record his indebtedness to Mr. C. J. Lewin for allowing him to make use of his leaf curl data; to Mr. T. Laycock for his valuable advice on the diagnosis fungoid lesions; to Messrs. W. B. Dowson and T. Thornton for their help in matters of cultivation and labour supply; and finally to Mr. O. B. Lean for taking bollworm moths to England for identification.

Mention should be made of the care with which Messrs. J. U. Udom and D. B. Akibola, African Assistants, carried out the field work entrusted to them.

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NOTES ON THE YAM PEST, *HETEROLIGUS CLAUDIUS*, KLUG., IN THE BENIN AND WARRI PROVINCES OF NIGERIA.

BY

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The Dynastid beetle, *Heteroligus claudius*, Klug., which ranges throughout Tropical Africa from Sierra Leone to Angola, is a major pest of yams in several districts of Nigeria—notably in the Benue Province (*vide* Lean, 1; 1928).

Reports of damage by these beetles were received from the Government Farm at Ogba, near Benin City, in both 1924 and 1925, and the writer proceeded to that locality in May, 1927, to investigate the distribution and bionomics of the pest. The object of the present paper is to give an account of the data accumulated in the course of a few weeks of investigation between May and July, 1927.

PLAN OF WORK.

As many districts as possible were visited in the Benin Province and in the northern area of the Warri Province; in each district the local chiefs and headmen were interrogated and their yam fields were inspected. Time did not allow of visits being paid to the Auchi and Asaba Divisions of the Benin Province, so information was obtained by post from the Administrative Officers in charge. Specimens of *H. claudius* were found only in the vicinity of Benin City: it is possible that some of the information obtained from the local chiefs referred to another Dynastid pest of yams, *viz.*, *Prionoryctes caniculus*, Arrow, which has been reported from Kwale by Peacock (2; 1913).

The bionomical investigations consisted of the collection of adult beetles at light, the study of their habits in a cage containing growing yams and a search for the larval habitat. Attention was also paid to the possibility of the existence of parasites and predators of the beetles.

1.—DISTRIBUTION.

(a) Ogba Farm near Benin City.

Yams were first planted on the new Government Farm at Ogba in April, 1924, the crop suffered considerably from the attacks of beetles. In 1925, yams were sown on various dates between

March and May, beetles were very numerous and much damage was done to the crop; the March-and-April-sown plots suffered to a greater extent than those sown in May. In 1926 sowing took place in June and beetle damage was negligible.

(b) Benin City and Neighbourhood.

Six native farms were visited and it was ascertained that *H. claudius* was numerous about every third or fourth year. Interrogation revealed the interesting fact that, in five cases out of six, the farmers planted a few seed yams in February or March each year with the definite object of determining whether yam beetles were likely to be numerous in the coming season. These early-sown seed yams were examined periodically and the number of beetles under each was ascertained; if from 6-8 beetles were found under one yam in April the pests would be plentiful that year and planting would have to be delayed until the middle of June. In the 1927 season there were few or no beetles under the test yams and planting was commenced between May 3rd and 22nd; the period May 10th to 15th was most favoured.

It will be seen that the farmers practise a control method against *H. claudius* which appears to be efficacious, *viz.*, late-sowing to avoid the main migration of the pest, which, the writer was informed takes place in April. The farmers stated that they would prefer to sow their yams in March or April as the present late sowing is liable to result in a shortage of seed for the succeeding season, but experience has taught them that early-sown yams are severely attacked in certain years, whereas late-sown yams are almost entirely immune.

The writer has been informed by Mr. S. M. Gilbert that a heavier crop of tubers can be obtained from early than late-sown yams at Benin in spite of beetle damage to the former; but a prejudice exists in the local markets against tubers bearing beetle lesions.

(c) Other Districts.

Ten districts were visited, in eight localities the yam beetle was not considered to be a serious pest, while in the remaining two (Oghada and Ubiaja) it was only occasionally of major importance. Of the two Divisions of the Benin Province not visited by the writer, *H. claudius* was responsible for considerable damage to the yam crop only in the western area of the Auchi Division.

The information obtained from various sources is tabulated below.

TABLE No. 1.

Locality.	Province.	Approximate distance and direction from Benin City.	Time of Yam Planting.	Part of crop attacked.
Sapele	Warri ...	30 miles S.	Late May to early July	Tubers only.
Kwale	„ ...	48 „ S.E.	April to May ...	„ „
Usonigbe	Benin	42 „ E.S.E.	March to May..	„ „
Agbor	„ ...	40 „ E.	Mid-April to May	„ „
Ubiaja	„ ...	58 „ E.N.E.	March to May...	Tubers and new seed.*
Oghada	„ ...	34 „ E.	March and April	Seed and tubers.
Igoriaki	„ ...	14 „ W.N.W.	May	„ „ „
Igwobuzuwa ...	„ ...	21 „ W.N.W.	April and May...	„ „ „
Ekenwan	„ ...	21 „ W.S.W.	„ „ „ ...	Seed and new seed.*
Ehor	„ ...	32 „ N.E.	March to May...	Seed only.
Auchi	„ ...	68 „ N.E.	Dec. to March...	Seed and tubers.
Ogwashi-Uku (Asaba Division)	„ ...	62 „ E.	March to May...	Tubers, rarely seed.

* New seed refers to the seed yams obtained after the main harvest has terminated.

The only district in which *H. claudius* was reported as being serious in 1927 was Auchi, it will be seen that the time of planting adopted is considerably earlier than is the case in any other locality.

It is a curious, and perhaps significant, fact that the three localities where beetle damage is sometimes serious lie between east and north-east of Benin City.

At Ubiaja and Auchi large white grubs have been found attacking yams, these are probably the larvae of *H. claudius* (1; 1928); the chiefs in all other localities had never seen grubs attacking tubers in their yam fields.

The different nature of the attack in the various localities is of interest; the beetles do no damage early in the season in the first five localities (*see* Table No. 1), four of which are on the eastern side of Benin City.

There is little difference in the methods of cultivation employed in the various districts; typically the bush is cleared and burnt and yams are planted, then the land is left fallow for about three years. At Agbor and Ubiaja very large continuous areas of yams are planted, the crop being the property of a number of farmers. A local chief at Agbor informed the writer that this system of communal planting was introduced only about four years ago and that beetles were practically absent now, although they used to be serious pests on the small farms of the past. The chief was of the opinion that the greater exposure of the large fields to sunlight was the controlling factor.

2.—Bionomical Data.

(a) Migration.

A record was kept of the numbers of beetles taken at light after the writer's arrival at Ogba on May 11th, the results obtained are tabulated below :—

TABLE No. 3.

Week ending :—	No. of adult beetles collected.
May 17th	1
„ 24th	19 (16 on May 24th).
„ 31st	7
June 7th	8
„ 14th	1

In addition one beetle was taken on June the 19th, and another on July 2nd. This scarcity of beetles suggests that the main migrationary period occurs earlier as stated by the local farmers.

(b) Depth of Beetles in Soil.

A wire gauze cage two and a half feet square was erected on May 27th, the depth of the cage was also two and a half feet of which one and a half feet were below ground level.

Ten seed yams were planted in the cage and nineteen beetles were introduced; between May 27th and June 7th twenty more beetles were placed in the cage. The soil in the cage was removed to a depth of eighteen inches on June 13th and again on July 11th; on August 1st the soil was excavated to a depth of four feet. After each of the first two examinations the soil was replaced and any beetles which had been found were placed on the top of the soil. In Table No. 4 is given the number of beetles found at various levels.

TABLE No. 4.

Depth in soil.	No. of beetles on :—		
	June 13th.	July 11th.	August 1st.
Surface	4 (dead)	0	0
0–4 inches	0	1	0
4–8 „	7	2	3
8–12 „	0	5	2
12–18 „	2	0	5
18–24 „	...	...	3
24–30 „	...	...	1
30–48 „	...	...	0

The beetles found in the soil remained quiescent for from one to three minutes after being exhumed; after that period they became active and rapidly buried themselves in the soil.

(c) Damage Survey.

On May 18th 470 seed yams were planted in two ridges, each 330 yards long. Periodic examinations were made of the seed: on June 9th there were thirty shoots above ground and no beetles; on June 29th 110 stands were examined and it was found that five seed yams showed traces of beetle attack though no beetles were seen. Mr. G. W. Lines very kindly undertook the harvest and examination of the crop from these seed yams after the writer's departure from Benin. The results of Mr. Lines' investigations are tabulated below.

TABLE No. 5.

	Total No. of tubers.	Weight of tubers in lb.	% attacked by beetles.
Block L. (110 yards)	198	407	19·2
Block M. „	160	478	6·2
Block N. „	172	411	7·0
Averages	177	432	11·3

Block L. was nearest to the bush on the Plantation boundary. Mr. Lines states that there was scarcely any beetle attack on the main yam plots on the farm which were sown more than twelve days later.

(d) Larvae.—Very exhaustive searches made for larvae in decayed timber in the vicinity of Ogba Farm, and elsewhere—gave negative results. It has since been found (1; 1928) that the breeding season commences in October, *i.e.*, after the writer had left Benin.

(e) No parasites were found. A farmer stated that the Red River hogs, *Potamochoerus* sp., dig up the beetles and feed on them and, on one occasion, the writer observed that the soil in a yam field had been disturbed by these mammals though he could find no evidence of what the herd had been feeding on.

Summary and Conclusions.

1. Observations were made on the bionomic, distribution and pest status of *Heteroligus claudius* in various localities in the Benin

and Warri Provinces. Local chiefs were interrogated and their fields were searched for beetles in all localities visited.

2. It was found that in the vicinity of Benin City the farmers plant a few yams in February or March each year with the object of determining whether beetles are likely to be numerous in the coming season. If few or no beetles are found under the test yams, planting is carried out in May; if beetles are numerous, planting is delayed until mid-June. The farmers have found that late-sown yams are almost entirely immune to beetle attack.

3. Information was obtained from twelve other localities, in only three of which *H. claudius* was regarded as a serious pest (in certain years); all three of these districts lie between east and north-east of Benin City. In two of the three localities large white grubs had been found attacking yam tubers, but a similar observation had not been made in any of the remaining districts (including Benin City).

4. At Agbor the writer was informed that *H. claudius* was a serious pest up to about 1923 when a system of communal yam planting was instituted by the local farmers.

5. Few beetles were taken at light from May to July and it seems probable that the main migration takes place earlier. No parasites or predators were found.

6 It appears that *H. claudius* is only of importance at Benin City on early-sown yams and at Auchi, Ubiaja and Oghada in certain years. Control methods are being tested by Mr. Lean in the Benue Province this year, and it would seem advisable to await the results of these experiments as the damage done by *H. claudius* in the Benin Province is not so serious as to call for immediate action being taken.

Acknowledgments.

In conclusion the writer wishes to express his indebtedness to Mr. G. W. Lines for computing the damage on the special yam plots; to Dr. G. A. K. Marshall and Messrs. S. M. Gilbert and R. Nicol for providing him with information; to the Administrative Officers at Benin City, Ubiaja, Agbor, Kwale and Sapele for the assistance and hospitality extended to him in the course of the investigations.

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A DYNASTID BEETLE AS A SERIOUS PEST OF YAMS IN THE BENUE PROVINCE OF NIGERIA.

BY

OWEN B. LEAN, B.SC., D.I.C.

During recent years the dynastid beetle, *Heteroligus claudius*, Klug. has been found to be a very serious menace to the yams grown by the Munshi people of the Benue Province of Nigeria. In the badly infected areas this beetle has been the cause of considerable famine during the months when the native relies on the yam for his main source of food.

Early in May, 1927, the author proceeded to the Agricultural Department's Experimental Farm at Yandev, between Abinsi and Katsina Ala, to study this pest. In the middle of September he had to leave for Ibadan where cage experiments were continued. At the end of October a short time was spent at Yandev. During the author's absence observations were kept by the Superintendent of Agriculture.

The present paper is a report of the progress of the beetle attack during the 1927 yam season in the Benue Province and on the results of the cage experiments. During the present (1928) yam season further investigations are being undertaken.

PLAN OF WORK.

The following were the main lines of investigation :—

1. Collection of all possible information regarding past outbreaks.

2. Determination of the importance, distribution and intensity of the beetle attack in the Munshi Districts of the Province.

3. Comparison of the agricultural methods and ecological characters of districts suffering heavy attack with those where the damage was negligible.

4. Study of the progress of the beetle attack in the bad areas.

5. Breeding the beetle under laboratory conditions.

6. Breeding any Melolonthid larvae found in likely breeding places.

7. Testing different cultivation methods on the Experimental Farm.

Summary of Knowledge of Previous Attacks.

Dates of Outbreaks.—A number of District Heads gave the information that they recall severe outbreaks of the beetle many years ago—probably about twenty years—but from that outbreak until 1919 no serious damage is remembered. The beetle reappeared in numbers in a few localities in 1919 though it was not until 1925 that the attack became general and of great importance. In 1926 the beetle was probably at its worst and though in the 1927 season the attack was very severe it was probably less than in 1926 and the area of infested territory seemed somewhat reduced.

Distribution.—Beetle attack on yams has previously only been reported from the Benue Province, Benin (Golding, 1) Afikpo and Kwale (the beetle is of a different species in the two latter localities) but I have been informed by reliable natives that the beetle is known in the following districts:—Oyo, Ibadan, Owerri and Onitsha and typical lesions have been seen on yams between Jebba and Abeokuta It seems likely then, that one of the two species is present in most of the yam growing districts of Nigeria, though their numbers rarely attain epidemic proportions.

In the Benue Province very little exact information was obtainable as to the more exact local distribution though the beetle was generally considered unimportant in the more southern districts.

Seasonal Attack.—There was a general opinion that good early rains are followed by slight beetle attack. The beetles were supposed to appear at the commencement of the rains and the attack to be at its worst in June and July and the beetles to disappear in October. Nothing was known of the grub.

Control.—During previous attacks the Political Officers have advocated the use of light traps in the form of fires built in the yam fields beside pots sunk in the ground and full of water.

Effects of the Outbreaks.

The damage caused by the beetle is having widespread effects on the Benue Province.

Direct Food Shortage.—In the bad areas where the yam crop is almost totally destroyed the natives are without proper food from the time the guinea corn is consumed—March or April—until the ripening of the maize. Previous to the food shortage the maize crop was regarded as more of a luxury than a food crop and even now the idea persists and no great quantity is grown. The famine cannot therefore be said to terminate until the harvesting of the Gero (Bull-rush Millet) in July.

The food shortage necessitated the introduction of the Native Administration Famine Relief Scheme by which grain was distributed to the natives in place of money wages and three food dumps were instituted where the natives could buy grain. In districts such as Tongov, little effected by this relief, villages have been seen subsisting entirely on a miscellaneous collection of leaves and fruit collected in the bush.

General Reduction of Crops.—Yams that would normally be kept for seed have to be used for food and consequently the acreage of yam farms has greatly diminished. Seed yams, after planting, are often dug up again for food as soon as the shortage is felt. In some districts, *e.g.*, Ugondo, there were villages where no yams were planted in 1927.

Since the Munshi relies on yam cultivation for opening up about ninety *per cent.* of his farm, reduction of yam crop necessitates a reduction of all the crops that follow in the rotation. The results on the Departmental Experimental Farm, Yandev, have clearly shown that neither Gero nor Benniseed will give good results on bush land. It is obvious, therefore, that any further yam losses will greatly inhibit the production of all other main crops unless the Munshi opens up his land with some other crop.

In contrast with the above deleterious effects of the beetle attack there has to be reckoned the satisfactory subversion of the conservatism of the Munshi. He is being forced to change his farming methods and to grow new crops. There has been, for instance, a marked increase in the cultivation of cassava and the maize crop is likely to increase.

Distribution and Intensity of the 1927 Beetle Attack.

Thirty-eight Munshi Districts, representing an area of some 5,000 square miles south of the river Benue, were visited during the investigations and information was obtained from Political Officers in the surrounding territory.

In general, it was found that the southern districts extending from Shangev W. to Shangev S. were free from the beetle and in some of these areas the beetle had never been seen. The beetle was common in all the northern districts, and the Katsina river intersected the infected area. But since the beetle is scarce in Mbagen, Turu and Utange, all of which are close to the river, and as the beetle appeared at Yandev before Tombo W., which is nearer the

river, and since Shangev W. and Gav are well supplied with waterways, there seems to be no connection between the rivers and beetle attack. Neither was any variation observed in the vegetation that might effect the beetle's distribution.

Study of the more local distribution showed that in the infected areas the yam farms on the higher, well drained ground suffered much less than those in the small valleys bordering on streams.

An interesting difference was found in the agricultural methods employed in the immune southern zone as compared with the north. In the more northern districts, after the yams have been harvested, the heaps are left undisturbed and the Gero seeds are sown upon them and the heap is only broken up after the Gero is harvested when the guinea corn is sown broadcast over the farm. In the southern districts the Gero is sown broadcast and the yam heaps are scattered over the seeds.

In the southern districts the farmers make much more effort to plant the yams before the first rains. In the north many farmers plant well into the rainy season and as late as May and June. In Gav full sized yams were obtained at the end of July, but in the northern districts they were not ready until September.

Summary of Pest Conditions in the Munshi Districts.

The following summary is compiled from notes taken during several treks taken from May to September.

Abinsi.—Abundant.

Gav.—Beetle unknown.

Ipav.—Not very many in the south but numerous in the north.

Harev E.—No beetles reported.

Ikurav N.—Very few at Agahanda but bad in parts; many last year.

Kunav S.—Beetle unknown.

Kunav N.—No damage.

Mbagen.—Beetle not known recently but common some years ago.

Mbakor.—Very common.

Mbatiav.—Only a few beetles in the north and none in the south.

Mbatierev.—Very common and common last two years.

Mbayon.—Abundant for several years.

Nanev.—No damage and very few beetles.

Nongov E.—Not bad until last year; very bad last year; had not been noticed by June 30th, 1927.

Nongov W.—Bad last two years; beetles were coming in on June 28th, 1927.

Shangev S.—No beetles.

Shangev W.—No beetles.

Tombo E.—Many beetles but not as bad as last year.

Tombo W.—Very severe.

Tongov.—Very severe.

Turan.—Beetles unknown.

Turu.—Much damage last year but very few beetles this year.

Ugondo.—Very bad in the south last year but beetles had not arrived by June 10th, 1927.

Ukan.—No beetles in the south; many last year for the first time.

Ukum.—Attack not nearly as bad as last year.

Utange.—Bad in parts.

Yandev.—Very severe.

Summary of Pest Conditions in the Surrounding Country.

In the *Wukari Division* of the Benue Province the beetle is reported as a serious pest on the western fringe of the division, particularly in Awe, Wukari and Takum. It is comparatively rare elsewhere but few yams are grown in the eastern section.

In the *Nasarawa Division*, on the north side of the river Benue, the beetle is known in every district but in no district has it been known in recent years to attain epidemic proportions. It is said to be found in greater numbers on new farms than on farms that have been worked for a year or more.

The beetle is known in the *Idoma Division* but does not seem to be much of a pest except around Oturkpo and the south eastern corner of Egedde District where that area adjoins Shangev W. and Gav. In Oturkpo District the beetle does most harm where the farmers remain on the same farm for several years.

The beetle is known in the *Ogoja Province* where that province adjoins Munshi country. In Yachi and Yakoro in Ogoja District the beetle was apparently bad about four years ago but not recently. The people of Obudu, however, say they have suffered from the

beetle for the last two years but not much before. It is reported to appear at Obudu in July and August.

Specimens have only been received from the Nasarawa Division and it is possible that in some districts, especially in the Ogoja Province, the beetle may be of the other species.

History of the 1927 Attack.

As a result of last year's beetle attack seed yams were so scarce in the Yandev District that the yam experiments on the Plantation were greately impaired. A small area, under six varieties was sown on April 24th, but no large area was sown until the middle of June. It was thus impossible to observe the progress of normal beetle attack on the Plantation. Actually no beetles were found there until July 29th, and even at the end of the season very few were found although at the end of May and in June flying beetles were attracted to light in numbers.

The first beetles were caught at light at Yandev on May 23rd, and shortly after they were found on the native farms. The appearance of the beetles coincided with a sudden increase in rainfall.

It seems impossible to detect the infected yam heaps by the condition of the vines, since the beetle only destroys the seed and new tubers and does not destroy the ordinary root system. After an evening's rainfall it is possible on the following morning to distinguish the heaps that have been entered during the night by the presence of the hole in the soil which is usually close to the base of the vine. The beetles prefer plants where the growth is luxuriant above ground—presumably because of the extra shade. The beetles avoid the heat of the sun by boring down 1-2 feet below the yam in the daytime and they are only found feeding in the early morning and during cool and cloudy days. If the fresh tubers have not begun to form the beetle destroys the seed yam first and then consumes the new yam as it develops. At Bogundu (Tombo W.) the District Head said that almost all the seed yams in the earlier planted farms were totally destroyed.

The beetle attack commenced earlier in the Yandev District than in many parts—in most they appeared in the middle of June and the natives think that they were later than in previous years.

In the native farms the beetles seemed to become more and more numerous until August and September. In October they were still found in small numbers. Towards the end of the rains they bury themselves deep in the yam heap and the dry weather appears

either to kill them off or to induce a migration. In November beetles were reported flying at night at Abinsi. A curious feature of the attack was that towards the end of the season when the yams were being harvested, many of the beetles were of a small type.

Observations on the Damage to the Yams on the Plantation.

The Superintendent of Agriculture undertook an analysis of yams harvested from two small plots on the Plantation. One plot of a one-fourth acre was sown on April 24th (the earliest sowing date on the Plantation) and the other of one and a half acres was sown on June 14th. Tubers harvested at different dates were classified according to the extent of the beetle damage and the number of beetles found was recorded.

These results are of no value for comparing the beetle attack on early and late planted yams since the early yams constitute a trap crop and preserve the late yams from severe infestation; they are presented to illustrate the progress of the beetle attack.

TABLE No. 1.

Early Planted.	Results Per Acre.							
Harvest date.	Number beetles.	Total tubers.	Tubers badly attacked.	%	Tubers slightly attacked.	%	Tubers undamaged.	%
Sept. 10th ...	72	436	48	11	112	26	276	63
Oct. 8th ...	16	1,144	192	17	212	19	740	65
„ 21st ...	12	824	168	20	108	13	548	67
Jan. 16th ...	0	788	28	4	128	17	632	84
Total ...	100	3,192	436	14	560	18	2,196	71
Late Planted.								
Total ...	...	1,211	1	·05	6	·5	1,204	99·45

Cage Experiments.

Food Consumption.—Under cage conditions the weight of yam consumed by the beetle was surprisingly low. Average figures show that each adult consumed only 1-2 grams of seed yam per week.

Alternative Foods.—A number of possible alternative foods were placed in the beetle cages but none were touched except potato tubers and very little was taken of that.

Breeding of Miscellaneous Grubs.—Several different species of melolonthid beetles have been bred from grubs found in various habitats.

Longevity of Adult H. claudius.—The adult beetles proved very long lived when confined in cages with damp earth and with yam for food, as is shown in Table No. 2. Even without food they can still survive for long periods as shown in Table No. 3.

TABLE No. 2.

No. of days from placing in cage to death.	20 beetles caged, May 27th.	48 beetles caged, September 29th.	20 beetles caged, October 13th.
1–10	3	3	1
10–20	...	8	1
20–30	...	5	4
30–40	...	4	7
40–50	...	5	7
50–60	4	5	...
60–70	1	6	...
70–80	...	3	...
80–90	...	4	...
90–100	...	...	...
100–110	...	...	...
110–120	...	2	...
120–130	...	...	...
130–140	...	...	...
140–150	1	...	...
150–160	4	...	...
160–170	1	...	...
170–180	2	1	...
180–190	3	1	...
190–200	1	...	...
200–210	...	...	...
210–220	...	...	...
220–230	...	...	...
230–240	...	1	...
Time of Death.			
May	2	...	..
June	1	...	...
July	4	...	...
August	1	...	...
September	...	...	...
October	5	19	3
November	4	15	17
December	3	10	...
January	...	1	...
February	...	...	...
March	...	1	...
April	...	1	...
May	...	1	...

TABLE No. 3.

FOUR BEETLES CAGED ON JULY 19TH AND UNFED.

Time of death.	No. of days from placing in cage to death.
August	18
,, ...	30
September	51
November	92

Oviposition.—Copulation was not observed until September and the females did not begin to oviposit until the beginning of the dry season when they ceased to feed on the yams provided. The first eggs were laid on October 19th, and the last eggs were found on December 23rd.

The eggs are laid in the soil at varying depths though never near the surface and not necessarily near a yam tuber.

In November an oviposition cage was arranged so that the females had a choice of soil for egg laying. In the first experiment half the soil was the ordinary soil from a yam field as used through the experiments, while the rest was taken from the bank of a small river and contained much rotting vegetable matter. During seven days, eight females laid twenty-one eggs in the ordinary soil and eleven in the stream soil. In the second experiment one-half of the soil was kept very damp while the rest was left normal. During seven days, the eight females laid 117 eggs in the wet soil and none in the dry. Furthermore only twice were adult beetles found in the dry soil.

Only four females were kept in separate cages and their oviposition periods were as follows:—

(1). November 21st—December 23rd, *i.e.* 32 days.
(2). November 20th—December 19th ,, 29 days.
(3). November 21st—December 3rd ,, 12 days.
(4). November 11th—November 24th ,, 13 days.

They laid 50, 34, 22 and 27 eggs respectively.

Average figures for eighteen females gave thirty-eight eggs per female In one cage containing six females the average was fifty-one.

They lay fairly steadily throughout the period and the maximum number laid by one female in twenty-four hours was nine.

The Egg.—The eggs show considerable variation in size and the early ones are nearly twice the size of those laid later. The early eggs are 4mm. long, broadly oval in shape with a smooth thin chorion. They are white in colour at first and later turn dull yellow or brown.

With 507 eggs the length of the egg period varied from twelve to twenty-six days as is shown in Table No. 4.

TABLE No. 4.

	Length of the egg period in days :—												
	12	13	14	15	16	17	18	19	20	21	22	24	26
No. of eggs	3	6	47	118	157	95	33	23	10	9	2	3	1

The eggs shrivelled if they became at all dry and much moisture was equally fatal.

The Larva.—The larvae are of the typical Melolonthid type. They are pale cream in colour with the head a rather light red brown and the tips of the mandibles black.

On hatching the larva is about 8mm. long, the body is broadest at the head, which is very pale brown, tapering to the anal segment. The legs are very light and the tips of the mandibles darkened. Quite early the terminal segments enlarge and the body tapers somewhat towards the thorax. For a considerable time the diameter of the head exceeds that of the first thoracic segment.

When full-grown the larva is about 80mm. long but the body is flexed into a crescent. The head is narrower than the first thoracic segment and the body is broadest at the penultimate abdominal segment, the final segment being rather cone-shaped.

As at the beginning of the experiments nothing was known of the larval habits the mortality was heavy and only sixteen adults were reared.

In forty-two cages stream soil, as used in the oviposition experiments, was employed; twenty of these contained pieces of yam and twenty-two had no yam. Eleven cages contained ordinary soil from the farm; five of these had yam and six had none.

In no cage where there was no yam were larvae bred up to the pupal stage. Twenty-four larvae pupated, in fifteen different cages. In four of the five cages containing ordinary soil with yam six larvae were brought to the pupal stage and one larva from the remaining cage is still alive (May 25th, 1928). Eighteen larvae were bred successfully in eleven of the twenty cages containing stream soil with yam. These results are summarised in Table No. 5.

TABLE No. 5.

No. of cages.	Type of cage.	No. larvae hatched.	No. larvae pupated.	% Pupated.
20 ...	Stream soil with yams	204	18	9
22 ...	Stream soil, no yams	205	0	0
5 ...	Plot soil with yams	39	7*	18
6 ...	Plot soil, no yams	43	0	0

* Includes one full grown larva which is about to pupate.

In the cages without yams most of the larvae died when they were about one month old and up to then appeared to be developing well. In the cages with yams, the larvae consumed the tubers freely.

The larval period varied from ninety-three to 141 days with an average of 122 days. The period for males averaged 112 and for females 124 days.

The Pupa.—Pupation occurred as follows:—

One larva pupated in February.

Three larvae pupated in March.

Eighteen larvae pupated in April.

Two larvae pupated in May.

Pupation took place in the soil but in no definite cell. In the cages the larvae sometimes came to the surface to pupate.

The pupal period varied from thirteen to twenty days with an average of sixteen days. No difference in the sexes was observed.

The pupa measures about 40mm. in length.

The Larval Habitat.

In October the author visited Yandev to look for eggs in the yam farms but without success. From that time farms in badly infested areas have been thoroughly examined and though the yam heaps have been scattered and the soil removed to a depth of 2-3 feet no larvae of *H. claudius* have been identified.

H. claudius has been bred from adult to adult in cages but neither the eggs, larvae or pupae have yet been found in the field. There can, however, be no doubt that the larva lives in the soil. Though it was shown that females prefer to oviposit in damp soil the larvae seem to prefer ordinary soil without the humus found near streams. Although they could develop for some time without feeding on yam, such food, or perhaps some substitute, seems necessary to complete metamorphosis. The most likely breeding place, then, would appear to be in old yam farms, in the lower levels of the fields, deep in the soil in the yam heaps. Rubbish heaps seem a possibility but they have been examined without result.

Possible Control Measures.

1. Should it be found that the larvae do develop in the yam heaps, scattering of the heaps after the yam harvest to expose larvae or pupae to the heat of the sun should afford a simple yet effective control.

2. Late sowing has been suggested and has been employed at Benin to avoid beetle attack. In the Benue Province, since the beetle is active and long lived through the wet season, this seems impracticable. Early sowing on the other hand could give the plant a start before the coming of the beetle. Early sowing has been shown to be the way to obtain large yams and early sowing could mean early harvesting. It might prove efficacious to encourage harvesting all the yams at an early date rather than leaving them in the ground until required for food.

The difficulty of advocating early planting to reduce percentage damage to the tubers is that it is quite useless unless the majority of the farmers adopt the measure simultaneously. Should but a few farms be planted early, the majority of beetles, when they appear, will find these farms and the later sown farms will enjoy comparative immunity. In this way the success of late planting, as

has been experienced by the native as well as on the experimental farm, is more apparent than real—the benefits may only be enjoyed by a limited proportion of farmers. If all farms are sown early all farms should gain a reduction in percentage loss: if all farms are sown late there would probably be no harvest in the areas where the beetle is common.

3. Trap crop control is suggested by the above. A few yams in each farm could be planted early before the beetle migration and these could be dug up after the migration when the majority of yams would be planted.

4. The light traps devised by the Political Officers have not been generally adopted as the farmers found that but few beetles were attracted. The Munshi has no form of lamp and a fire is not efficient.

5. Hand-collecting, already practised a great deal, should be encouraged.

6. Staking should discourage the beetle.

7. Deep planting has been suggested but since the beetle normally burrows deep it seems that it might prefer such cultivation.

Acknowledgments.

Throughout the experiments, the assistance of Mr. I. E. James, Superintendent of Agriculture, Yandev, has been of the greatest value. The author also wishes to record his thanks to all the Political Officers who have supplied information and have always been keen to assist the inquiry.

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ADMINISTRATIVE REPORT—1927.

BY

Mr. A. J. Findlay, Assistant Director, Southern Provinces.

Staff, European.—The scheme of re-organisation of the Department came into being on 1st April, 1927, whereby the Senior Superintendent of Agriculture, Southern Provinces, became Assistant Director of Agriculture, Southern Provinces, and was provided with a Deputy. The staff of Superintendents for the Southern Provinces (including Ilorin) should be fifteen, but the number available never exceeded ten.

African.—The members of the permanent African Staff averaged thirty-two in number, of which nineteen were trained assistants occupying positions in the higher grades. Lower grade members numbered fifty. There is still a deficiency in well-trained assistants which is now being made good by the absorption of pupils trained in the Agricultural School, thus providing a well-trained and efficient native staff. A considerable temporary native staff is employed each year for cocoa extension work and cotton inspection.

2. *Weather and Rainfall.*—Generally speaking the year was an unfavourable one from a weather and rainfall point of view. Rainfall in many areas was much below normal and even where it was normal in quantity, it was abnormal as regards the time of falling, *e.g.*, heavy rain in October instead of in September. Weather about the middle of the year was dull and cool, but unfavourable for agriculture. As a result of the unfavourable weather conditions, there was a shortage of crops, both food and export. The export of palm oil and palm kernels showed an increase over 1926, but the volume of palm produce exported is not controlled by weather but by prices. Cocoa which was much affected by the dull weather about July and the lack of rain at the critical period, showed a decrease of five *per cent.* for the season. Cotton was also an exceedingly poor crop, largely due to unfavourable weather conditions. Local food crops suffered likewise.

3. *Experimental Stations.*—There are four main experimental stations in the southern circle, at Ibadan, Benin, Umuahia and Ilorin which latter, for convenience of control and management, is included, and two sub-stations at Agege and Calabar. The details of experimental work are contained in the Station reports, but the principal points of interest and value are commented on here.

Moor Plantation, Ibadan. –Most of the experiments have been designed with the object of studying the practice of green manuring for annual crops and finding crop rotations to suit local conditions. The practice of green manuring in the rotations has been so successful that on blocks of land which have been cropped continuously since 1912, good crops of maize, yams and groundnuts are still harvested. Some of the maize crops have been outstanding when compared with crops on native farms. The crops have steadily improved in the last few years.

The experiments have reached the stage when definite recommendations are fully justified, and parties of farmers have been brought in to visit Moor Plantation and see the results for themselves, in the hope that they will be persuaded to give our improved methods a trial. They were duly impressed, and, provided their natural conservatism can be overcome, they may be expected to give our methods a trial. A large number of experimental plots were also arranged to test the yielding qualities of the improved Ishan Cotton Strains A. and B. as against the ordinary native cotton grown in the Southern Provinces.

Ogba Farm, Benin.—Although the farm was opened in 1923, the experiments have not yet reached the stage of showing definite results which can be regarded as conclusive. It has from the beginning been realised that soil conditions were poor, yet fairly representative of the surrounding country, and an attempt has been made to find out what crops both annual and perennial can be grown and with what degree of success under the particular conditions. Not only that, but the Department has set itself the task of showing that such land can be improved by following proper methods and suitable rotations in which there is continuous cultivation in contrast with the local custom of allowing land to revert to bush for a period of years.

As regards perennial crops, results so far show that oil palms can be quite easily and successfully established without stumping and without completely clean cultivation. Thorough stumping and cultivation would undoubtedly be an advantage but uneconomical; the important points are—to keep the young palms ring weeded and keep down bush, even grass, which competes seriously with the young palms. The prospects for kola seem good so far, and coffee grows well if properly planted and tended in the initial stages. Cocoa cultivation has proved rather difficult and disappointing; soil conditions are so unfavourable that it has been found almost impossible to establish cocoa on some plots, yet the conditions seem

to be just on the border line, for where there is even a slight improvement, the effect on cocoa cultivation has been very marked. The conclusions to be drawn meantime are:—on land of that type the cocoa seedlings have to be nursed in order to get them established; the land should be well cleared, plenty of temporary shade planted and established before the cocoa is planted and the land should be kept clean to avoid competition from weeds, bush and grass which soon very adversely affect the tender cocoa seedlings. Cocoa cultivation would be rather expensive under such conditions and on land of that type it is probable that cocoa trees would die off prematurely; this does not mean to imply that cocoa cultivation cannot be successful in the Benin area for there are many places within a few miles of Ogba Farm where cocoa has been grown with marked success and there are very extensive areas in the Benin Province where conditions for cocoa cultivation are most favourable. The question of Hevea Rubber cultivation has not been touched, for it is well known and amply demonstrated that rubber will grow successfully in the Benin area where other permanent crops will fail.

The experiments with annual crops do not yet call for particular notice as they are meantime in the intermediate state, but give prospects of yielding interesting results in the near future. Crops on such poor soil have often been very disappointing but it seems certain that with careful and considered cultivation there will be a decided improvement in the near future.

Umudike Farm, Umuahia.—Practically the same remarks apply to this farm where soil conditions are even worse than at Benin. The soil is a coarse sandy one with less body and less retentive powers than the Benin soil. It is probably below the average of the surrounding country and has yielded crops which on first consideration seem discouraging, but are really only to be expected on poor land which is being continuously cultivated with the object of ultimate improvement. Should the expected improvement materialise (there is no reason to doubt that it will) the farm will be an excellent object lesson that even poor land can be continuously cultivated and improved without the aid of artificial manures, but by methods which will eventually appeal to native cultivators.

In establishing the plots of oil palms, it has been definitely demonstrated that it is a decided advantage to keep the palm ring weeded and free from competition with secondary bush. Palms planted in unstumped rides cut in bush made such poor growth that it was soon evident that this method of planting could not be successful; when the bush was cut down, and keep down, the palms quickly responded. Thus for palm planting, the land need not be

thoroughly cleared by stumping, but it is essential that the bush growth should be kept thoroughly under control by frequent cutting and the palms should be ring weeded to give satisfactory results. Intercultivation is a further advantage, but is not essential.

The establishing of cocoa plots has been a very " uphill " business on such poor soil, and it has already been demonstrated that under such conditions clean weeding and vegetable mulching are essential factors in success in establishing and subsequent progress. The provision of ample temporary shade must not be omitted. It is probable that intercultivation with cover crops will yield good results.

The Department's principles and methods with regard to annual crops are being studiously continued, and with good farming it is hoped that interesting and useful results will be available in the near future.

An interesting series of experiments comparing native practice with our methods is in progress, but has to be continued over a series of years before definite results are obtainable.

Sub-Station—Calabar.—Only oil palm plots are now maintained at Calabar, and they have been yielding valuable information concerning the yields of different types of palms and the efficiency of different types of small palm oil presses. The investigations are still in progress and the Botanist has made a start with breeding the oil palm for improvement.

Ilorin.—Conditions at Ilorin are in many respects akin to those at Ibadan and experiments have been carried out on somewhat similar lines. The crops under experiment are yams, cotton, guinea corn and groundnuts, and experiments are being carried out with a view to finding rotations which will incorporate those crops in a manner suitable to local conditions and requirements; a prime consideration is that in any one year of the rotation there must be a food crop and an export crop, and not two food crops or two export crops, particularly the latter.

Intercultivation of suitable crops is also being investigated, and trials of cotton varieties with a view to deciding on the variety most suited to conditions in the Middle Belt.

Sub-Station—Agege.—The only point of interest about the kola and cocoa crops was that they were both very poor during the past season. The Agege kola plots are valuable sources of seed which

is widely distributed. The cocoa still yields a profitable crop in spite of the mortality amongst the trees, caused by unfavourable sub-soil conditions.

4. Multiplication of Improved Ishan Cotton.—3,000 lb. of seed of improved Ishan cotton were available this year from the Senior Botanist. This seed was given out to farmers in the Meko and Oyo areas under our supervision, and by exercising great care to reduce seed wastage the total area planted amounted to 1,336 acres. Only 12.5 *per cent.* of this acreage was grown as a sole crop, for 41.5 *per cent.* was planted in yams and forty-six *per cent.* through maize, so that a maximum yield per acre is not to be expected. Unfortunately the season 1927-28 proved to be a very poor one for cotton, nevertheless over twenty-five tons of the improved seed will be available for distribution to farmers next season. Used economically this seed is sufficient for over 25,000 acres, which would produce over 2,500 bales in a good season. Such rapid progress is not to be expected, but in order to reduce wastage, it is proposed to sell this seed at a halfpenny per pound. By having available for cotton farmers an indigenous cotton proved to be suitable for Southern Nigeria and worth at least three farthings per pound of seed-cotton more than the cotton commonly grown, an important step forward has been made in the development of the cotton industry.

5. Oil Palm Groves. Definite progress has been made in obtaining and laying out plots in the Eastern Provinces for the purpose of studying and demonstrating the improvement of oil palm groves by judicious thinning, planting and tending, which means ring-weeding young planted palms and frequent cutlassing the bush to prevent it from competing with the older palms. Eleven experiments have now been laid down mostly in palm groves belonging to individuals who realise the possibilities of and necessity for improved methods; the experiments consist mostly of four and a half acre blocks arranged in half acre plots so that there are four cleared plots alternating with five uncleared or control plots. The cleared plots have been thinned and planted in accordance with a decided scheme which is designed primarily to determine whether or not young planted palms can be successfully reared under old high wild palms standing on the ground to the extent of fifty or sixty to the acre. It is intended that the old palms should yield a return while the young palm are maturing and that the old and comparatively unproductive palms should be thinned out gradually until there remains a plot consisting of old but fully productive palms and young palms which have been reared to the productive stage under favourable conditions. Eventually the plot should be almost, but never quite, comparable to a plot of planted palms.

All the plots have been granted voluntarily by the owners, who agree to do all the work with the exception of planting and ring weeding young palms (in which they assist) and the weighing of the yields of palm fruit, done by the " clerk in charge ". Naturally the trees and the fruit remain the property of the owner of the grove, freely and quite unconditionally. It is too early to forecast results, but present progress and conditions lead us to hope that interesting and valuable results will be obvious in a few years, probably long before the planted palms come into bearing.

A few intelligent and progressive land-owners have sought and been given the assistance of the Department in laying out small oil palm plantations which they hope to add to annually.

6. Palm Oil Presses.—Demonstrations have been given in the Eastern Provinces of hand power oil presses and kernel crackers with the result that a healthy and extending interest has been created, and purchases of plant have been made. Native visitors to Moor Plantation have always been intensely interested in the small scale plant in operation there.

7. Green Manuring Extension Work.—What may be regarded as an important phase in the experimental work of the Department has been reached in that as a result of experiments on our farms we are definitely able to recommend the adoption of green manuring by native farmers. Experiments at Moor Plantation have been most conclusive in this respect and some of the farmers who have visited the farm with the object of seeing the results for themselves have promised to give green manuring a trial. It has been hard to persuade them because they absorb with difficulty the idea of growing a crop from which they can obtain no immediate return. Had the particular leguminous crop which we recommend, *viz.*, Mucuna, been one which yielded a crop of edible beans, our task would have been greatly simplified, but we have been unable to find an edible bean which suits both green manurial purposes and local conditions.

However, by maintaining a policy of peaceful penetration we hope eventually to overcome the prejudices and conservatism of the native farmer. A few of the Ilorin farmers who have come in contact with the Department at Ilorin in its various activities, have been persuaded to give green manuring a trial.

8. Cocoa Extension Work.—The cocoa fermenting scheme which has been in operation since 1922 continues to extend and is gaining ground in the potential cocoa producing areas of the Eastern

Provinces. In the Western Provinces where the scheme was initiated, its effects are being seen in the marked increase in the quantity of fermented cocoa which is being sold and exported. The object of the scheme is thus being attained in those parts and our activities are being increased in other areas. The quantity actually handled under the scheme during the season 1927-28 was 802 tons, as compared with 589 tons in 1926-27. An increase is really not to be expected owing to the increase in sales of fermented cocoa direct to the exporters, which is what we desire. A pleasing feature of this cocoa extension work has been its application to the Cameroons Province, where, after a rather discouraging beginning, the scheme has found favour and promises to extend rapidly in the Kumba Division.

9. Produce Inspection.—The scheme started in 1926 entered upon its second year's trial and further justified its inception by its continued success.

As a direct result of the scheme, a great improvement was brought about in the cocoa crop; during the cocoa season, October, 1927 to April, 1928, the percentage of Grade I cocoa exported was 98.6, with the result that Nigerian Cocoa now occupies a well-recognised and higher position on the European cocoa markets. Palm kernels also showed an improvement in a reduction of the average percentage of impurities from 3.21 *per cent.* in 1926 to 2.93 *per cent.* in 1927.

There was little change in palm oil; a slight improvement in soft oil; the standard of purity was well maintained. An unsolicited request from the West African merchants to have the scheme extended to include the Eastern Provinces is a certain proof of its efficacy.

10. Cotton Markets.—The usual system of inspection of seed-cotton at certain established markets was continued, but unfortunately the cotton crop has been most disappointing. The weather conditions during the growing season were unfavourable, resulting in a much decreased yield, and the area actually planted was much less, owing principally to the unfortunate fall in price during the previous season. Instead of the usual output of about 10,000 bales, the present season will yield only about 3,500 bales.

11. Groundnuts at Ilorin.—Extension work started in 1926 has made encouraging progress as is evident from the export figures of 596 tons for 1927-28 as compared with 309 tons for 1926-27. The part played by the Department in this scheme for building up an

export industry in the Ilorin Province is—judicious propaganda, advice and assistance; the sale of good seed and the organisation of purchase for export, which consists really of a voluntary system of inspection, principally to ensure that the groundnuts are thoroughly dry. The buying and exporting firms have co-operated and so greatly assisted the scheme. An attempt is being made to stimulate interest in groundnut cultivation at Oyo and Meko, where conditions as regards soil and climate are very similar to Ilorin.

12 Agricultural Conference.—The first West African Agricultural Conference was held at Moor Plantation, Ibadan, in March, 1927, and was attended by thirty-four officers; five officers came from the Gold Coast and four from Sierra Leone; the remainder were members of the Nigerian Agricultural Department. Practically all the papers read were concerned with Agriculture in West Africa, and had particular reference to such products as oil palms, cocoa and cotton. There is no doubt that the Conference was a success.

13. Calabar Exhibition.—Much interest was shown in the exhibit of the Agricultural Department, which consisted mainly of continuous demonstrations of small scale palm oil extracting and kernel cracking machines suitable for African producers; of cocoa fermenting and drying, and of Para rubber preparation. There was also an interesting exhibit of Improved Ishan Cotton. The Exhibition served the Department well in bringing some of its activities to the notice of a large number of progressive African farmers.

14. Railway Trip of Selected Farmers.—An undoubted sign of progress and development was the trip which was organised by the Railway and Agricultural Departments for selected farmers from the vicinity of the Eastern Railway in the Southern Provinces. The thirty selected farmers were transported by rail to Kano, Zaria, Ilorin, Ibadan, Agege and Lagos, allowing time for visits to Agricultural Department farms and places of interest. There is no doubt that the farmers saw much of, and learnt much from, agricultural conditions in areas different from their own and returned to their homes with a broadened outlook and wider interests. The party was conducted by Mr. Gilbert, Superintendent of Agriculture, Umuahia.

A. J. FINDLAY,
Assistant Director.

Moor Plantation,
Ibadan,
5th July, 1928.

ANNUAL REPORT, MOOR PLANTATION, IBADAN, 1927

BY

H. G. Poynter.

Investigations and experiments have been carried out during this year on the same lines as in the past, with the main object of discovering the best system of continuous cropping that may be recommended to replace the native method of shifting cultivation. In the year 1927 some of the more important fertility experiments entered on their second rotational cycle of four years. Some of the other experiments, particularly the manurial, green manuring and cover crop experiments, add further evidence of the benefit to be derived from green manuring.

The weather during the early part of the year was disappointing from the arable farmer's point of view. The rainfall figures given below show that the total rain for the year was below average and also that little rain fell at the time when it was most needed, *viz.*, in the critical planting months of March and April.

Rainfall to the end of each Month.

	1927.	Average 1910–1927.
January	2·90	0·36
January—February ...	3·30	1·14
January—March	5·90	4·66
January—April	8·78	10·59
January—May	14·06	16·54
Total for year ...	46·55 inches.	49·72 inches.

Although on paper the lack of rain in 1927 does not look to have been very great, in practice it was severely felt. With comparatively long breaks of fine weather between the rains, the soil did not become sufficiently moist until late in the season and conditions of comparative drought prevailed. The result was that the early crops, especially early maize, gave lower yields than usual both on Moor Plantation and also on native farms in the vicinity.

The cotton crop was a failure at Ibadan this year. Badly attacked by leaf curl, the crop became stunted and withered, and produced only fifty to seventy lb. of seed-cotton per acre. The late planted maize was the most satisfactory crop, and in many plots the yield of dry grain was over half a ton to an acre.

Cover Crop Experiment (Table No. 1).*

	Yield of early maize in lb dry grain, per acre.	Odds that difference is significant.
Average yield of 10 plots following Dolichos	1,357	—
Average difference of 2 plots following Canavalia	−225 ± 199	7 : 1
Average difference of 2 plots following Mucuna	— 92 ± 199	2 : 1
Average difference of 2 plots following Cowpeas	—123 ± 199	3 : 1
Average difference of 1 plot following Dolichos dug in Dec. 1st	— 95 ± 280	—
Average difference of 1 plot following Weeds (not cultivated)	—464 ± 280	17 : 1
Average difference of 1 plot following Weeds (cultivated on Dec. 1st & Jan. 1st)	−172 ± 280	3 : 1

The cover crops were better on the whole than in previous years; as usual mucuna and dolichos made the best cover. The yield of early maize from this block was one of the best on the Plantation, considering the bad season and the fact that the soil in this area is not particularly good. The last four years are shown in the following table.

	1924.	1925.	1926.	1927.
Average yield of 10 plots after Dolichos ...	1,255	546	1,243	1,357
A difference of 2 plots after Canavalia ...	+ 42	− 10	− 171	− 225
A difference of 2 plots after Mucuna ...	− 115	− 18	− 111	− 92
A difference of 2 plots after Cowpeas ...	− 203	+ 31	− 145	− 123
A difference of 1 plot after Dolichos dug in Dec. 1st.	+ 223	+ 186	+ 54	− 95
A difference of 1 plot after Weeds	− 311	− 146	− 516	− 464
A difference of 1 plot after Weeds cultivated Dec. 1st. and Jan. 1st.	− 225	− 70	− 311	− 172

The yield of the plots following dolichos has been maintained, but as this season on the farm, and in the district generally, was a poor one for maize, the probability is that the land is steadily improving. The yield after canavalia is steadily decreasing; this cover is definitely inferior to dolichos or mucuna as a green manure planted in the late season. After mucuna the difference is constant and may be inherent in the plots, but in view of other results probably not; for growing at this time of the year dolichos seems slightly superior for it remains green longer. The chief merit of mucuna, as compared with dolichos, is its freedom from disease.

*The tables referred to in the text are to be found at the end of this report.

Cowpeas seem definitely inferior. The plot of dolichos dug in on December 1st is steadily getting worse in comparison with the standard plots on either side. Possibly the land was superior at first but it is quite possible that this process is definitely superior at first but not when continued year after year. Weeds, whether dug in or not, are markedly inferior, and on the whole these plots seem to be getting worse.

Dry Season Treatment of Cover Crop (Table No. 2).

	Yield of early maize in lb. of dry grain per acre.	Odds that difference is significant.
Average yield of 9 plots dug in at beginning of the dry season, Nov. 8th, 1926	1,652	—
Average difference of 8 plots dug in at the end of the dry season, March 8th, 1927	− 60 ± 59	6 : 1
Result in Previous year.		
Average yield of 9 plots dug in at beginning of the dry season	2,308	—
Average difference of 8 plots dug in at the end of the dry season	−102 ± 90	7 : 1

Treatment of Cover Crop Experiment (Table No. 3).

	Yield of maize in lb. of dry grain per acre.	Odds that difference is significant.
(A) Average yield of 5 plots burnt in February and dug in	1,523	—
Average difference of 4 plots burnt in February and moulded up	+99 ± 67	13 : 1
Result in Previous year.		
Average yield of 5 plots burnt in February and dug in	2,098	—
Average difference of 4 plots burnt in February and moulded up	+ 30 ± 130	—
Average yield of 5 plots cut in November and dug in at once	1,631	
Average difference of 4 plots cut in November and dug in in March	−169±128	10 : 1
Result in previous year.		
Average yield of 5 plots, cut in November and dug in at once	2,269	
Average difference of 4 plots cut in November and dug in in March	−22±122	—

These three experiments are still in their initial stages and will only give conclusive results after a number of years. Although the yields were below the average of 2,000 lb., usually recorded for early maize on this farm they were the best recorded this season. They were designed to corroborate by a larger number of plots the indication given in the cover crop experiment just described.

Of these three tests, the first shows the effect of digging in the cover crop in March, plus the effect of allowing the cover to remain growing on the land compared with digging in in November, and the third shows the single effect of digging in March compared with November. Any difference between the results of these two tests can therefore be ascribed to the single effect of a dry season cover crop cut compared with a dry season fallow. The second test constitutes a single comparison between two methods of preparing the land, *viz.*, digging in or split ridging as compared with moulding up the old ridges; the fact that the cover crop is burnt is incidental. At the same time, a comparison between the two blocks of land comprising tests 2 and 3 will eventually give a fair idea of the effect of burning the cover crop.

In all cases the mucuna cover crop was a good one and was fairly uniform throughout the blocks of land. In the first test, the maize following mucuna dug in in November was observed to be more backward at the end of April but by the end of May this difference was not noticeable. Again the March dug plots gave a lower, but not significantly lower, yield, although they showed a very slight improvement on last year's comparative returns. Similarly in the third test, the March dug plots were again inferior, but in this case the difference was more pronounced than last year. Hence it is probable that it is better to dig the cover crop in in November, and it is possible that if digging has to be delayed until March, it is better to allow the cover crop to continue growing. From a farming point of view it is less expensive to dig in in November when the land can still be easily worked.

Green Manuring Experiment, 1927 (Table No. 4).

	Yield, maize in lb. of dry grains per acre.	Odds that difference is significant.
Average yield of 7 plots following Mucuna	1,356	—
Average difference of 2 plots following Dolichos	+ 41 ± 60	3 : 1
Average difference of 2 plots following Canavalia	−110 ± 60	27 : 1
Average difference of 2 plots following Cowpeas	− 38 ± 60	3 : 1

The yield of Late Maize this season was greater than that of a similar crop in 1925 so that the fertility of this block appears to have been maintained. The cover crops on the different plots were at first, somewhat irregular; cowpeas and canavalia being less efficient in smothering weeds than either dolichos or mucuna as was the case in previous years, but when dug in all plots had a fair cover. There has been but little difference in the effect on the maize crop between

mucuna and dolichos; canavalia and cowpeas gave a slightly lower yield.

As an indication of the total amount of material buried when these cover crops were dug in, a number of ridges of the cover crop were weighed after cutting and just before digging in. The results were :—

Dolichos	...	17,380 lb. per acre
Canavalia	...	2,640 „ „ „
Cowpeas	...	3,630 „ „ „
Mucuna	...	13,530 „ „ „

It is remarkable and interesting that the very small weights of canavalia and cowpeas dug in are nearly as effective as the relatively high weight of mucuna and dolichos.

MANURIAL EXPERIMENT, 1927 EARLY CROPPING—MAIZE (TABLE NO. 5).

	Yield, maize in lb. dry grain, per acre.	Odds that difference is significant.
A.3N.		
Average of 7 unmanured plots	880	—
Average difference of 2 plots manured with cotton seed	+219±122	25 : 1
Average difference of 2 plots manured with phosphate	− 76±122	3 : 1
Average difference of 2 plots manured with cotton seed and phosphate ...	+163±122	10 : 1
A.3S.		
Average of 7 unmanured plots	1,565	—
Average difference of 2 plots manured with cotton seed	− 27±136	—
Average difference of 2 plots manured with phosphate	+ 14±136	—
Average difference of 2 plots manured with cotton seed and phosphate ...	+ 88±136	3 : 1

LATE CROPPING—MAIZE (TABLE NO. 6).

	Yield, maize in lb. dry grain, per acre.	Odds that difference is significant.
A.3N.		
Average of 7 unmanured plots	538	—
Average difference of 2 plots manured with cotton seed	+532±61	over 1,000 : 1
Average difference of 2 plots manured with phosphate	− 86±61	12 : 1
Average difference of 2 plots manured with cotton seed and phosphate ...	+518±61	over 1,000 : 1
A.3S		
Average of 7 unmanured plots	965	—
Average difference of 2 plots manured with cotton seed	+311±94	2,084 : 1
Average difference of 2 plots manured with phosphate	−122±94	10 : 1
Average difference of 2 plots manured with cotton seed and phosphate ...	+353±94	11,110 : 1

Rate of manuring cotton seed 13 cwt. per acre.
Rock phosphate (ground) 10 cwt. per acre.

This experiment was continued on the same principles adopted when started in 1923. The cropping this year was maize followed by late maize on both portions and the results may be compared with those published for 1924 when the cropping was the same. The poorness of the crops in the northern portion, in which rotation there is no green manure, was even more emphasised by the increase of yield of the plots which received nitrogenous manure.

Comparing the results with 1924, manuring with cotton seed has a distinct effect in both years in A3N where there is no green manuring, and had a little effect in A3S in 1924 but none now, presumably because the land is now richer.

Phosphate alone gives no constant or substantial result anywhere and the cotton seed and phosphate plots are always very similar to those from cotton seed alone; there was an increase on both plots in 1924, but this year the increase in A3S is less than it was in 1924. There appears to be no evidence that phosphate has a beneficial result either alone or with cotton seed or green manure, or with both. There seems to be a considerable difference between results from phosphate manure at Moor Plantation and at farms in Northern Nigeria.

EARLY MAIZE, 1927.

New Ridges *versus* Old Ridges Moulded Up (Table No. 7).

	Yield, maize in lb. dry grain per acre.	Odds that difference is significant.
Average of 20 plots ridged up	1,040	—
Average difference of 19 plots moulded up	+ 30±27	7 : 1

In this experiment results show but little difference for the deeper cultivation and may be compared with those on C5N, Treatment of Cover Crop Experiment.

One reason why the ridged up plots did not give a better yield after the more thorough cultivation, may have been lack of consolidation in the ridges. Owing to the exceedingly late cotton season the previous year, the cotton plants could not be uprooted from this block until the end of March when the new ridges were made, and this operation only preceded the sowing of the maize by five or six days, the maize on the moulded up plots being sown on much more consolidated ridges.

Late Maize Spacing Test, 1927 (Table No. 8).

	Gross yield of maize in lb. of dry grain per acre.	Odds that difference is significant.
Average yield of 20 plots 2′	1,220	—
Average difference of 4 plots at 1′ ...	+ 83 ± 59	12 : 1
.. .. .. 5 „ „ 1½′ ...	+ 51 ± 53	5 : 1
.. .. .. 5 „ „ 2½′ ...	− 56 ± 53	6 : 1
.. .. .. 4 „ „ 3′ ...	−327 ± 59	over 1,000 : 1

Maize planted on both sides of 6 ft. ridges.

This crop of late maize was one of the best grown on the farm, conditions during sowing and the early stages of growth being very favourable A very good stand was obtained and no supplying was necessary. All stands were thinned out to be a single plant. There seems to be but little difference in yield from stands up to about two feet apart but above this the yield definitely decreases.

The number of cobs required to make up 100 lb. were as follows:—

		Cobs per stand.
Maize planted at 1′ ...	503	·44
„ „ „ 1½′ ...	507	·71
.. .. .. 2′ ...	434	·80
.. .. „ 2½′ ...	436	·90
„ „ .. 3′ ...	424	·79

Yam Varieties, 1927 (Table No. 9).

	Gross yield of tubers in lb. per acre.	Odds that difference is significant.
Average yield of 10 plots, Iyawo ...	8,278	—
Average difference of 3 plots, Alade ...	−1,449 ± 800	27 : 1
.. .. .. 3 „ Odo ...	−2,031 ± 800	160 : 1
.. .. .. 3 „ Esinmirin	+1,261 ± 800	17 : 1

All the varieties are white yams. Iyawo is the most popular in the district, gives a big yield but only a few large tubers, the remainder somewhat small and all of a characteristic egg shape. Odo, although not a water yam, has a high water content and has to be stored before use. Esinmirin gives large tubers but not a big yield and Alade is somewhat similar to Iyawo but the tubers are very much longer; it is also the most subject to disease of these four varieties. Iyawo and Esinmirin are best for storing as they do not deteriorate for a long time.

Odo gave a definitely inferior yield. There is also an indication that Alade is a lower yielding and Esinmirin a higher yielding variety than Iyawo. Probably the abnormal season, in which the yam crop had a struggle in the early season and only recovered during the late rains, had a differential effect on the yield of these varieties.

Experiments Continued.

The following experiments have been continued this season and results will be published in future reports:—

	Commenced.	Results.
Stumping Experiment (Comparison between continuous cultivation and shifting cultivation in thick bush ...	1926	1930
Grass Fallowing Experiment	1922	1930
Four year Rotation	1923	1931
Two year Rotation	1923	1928
Main Rotation	1922	1930

New Experiments.

A new rotation has been started this season on thirty acres, in which the green manure is planted in the late maize crop and allowed to remain for fourteen months before digging in. The thirty acres has been divided up as follows:—

Demonstration	5 acres.
Experiment	10 ,,
Block cropping	15 ,,

Further details of this experiment will be published in 1928.

Cotton.

Cotton has usually found a large place in the Moor Plantation report but owing to the exceptionally bad season the experiments have not given reliable results. On some native farms in this district a cotton crop was established but on the gravel soil of Moor Plantation it was a failure and in many cases on native farms the crop was pulled up early and some other crop planted.

The new strains of Ishan A. and B. were tested against local cotton through early maize and as a sole crop on no less than 120 plots of one-fourth acre but the yields were negligible and the results not worth publishing.

Distribution of Plants.

Plants supplied from the nursery have included:—

200 Oil palms.
12 Coconut palms.
2,443 Kola plants.
392 Coffee plants.
115 Budded plants.
8,188 Ornamental plants.
2,313 Fruit trees.

Poultry.

(Rhode Island Red.)

579 Eggs for hatching and
11 Cockerels have been sold during the year.

H. G. POYNTER,
Superintendent of Agriculture.

Rainfall, 1927.

Moor Plantation, Ibadan.

Month.	Rainfall in inches.	Average rainfall for a period of eighteen years, 1910–1927.
January	2·90	0·36
February	0·40	0·78
March	2·60	3·52
April	2·88	5·93
May	5·28	5·95
June	9·71	7·48
July	10·16	6·47
August	1·03	3·43
September	4·32	7·23
October	6·98	6·44
November	0·29	1·99
December	0·0	0·14
Total	46·55	49·72

TABLE No. 1.

Cover Crop Experiment—1927.

Plot.	Late Season Treatment.	Crop.	Yield of dry grain lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block Y1.				
1	Dolichos	Maize	1,161	
2	Canavalia	„	1,195	− 248
3	Dolichos	„	1,724	
4	Mucuna	„	1,340	− 117
5	Dolichos	„	1,190	
6	Cowpeas	„	1,090	− 128
7	Dolichos	„	1,245	
8	Canavalia	„	1,023	− 203
9	Dolichos	„	1,207	
10	Mucuna	„	1,151	− 67
11	Dolichos	„	1,229	
12	Cowpeas	„	1,195	− 118
13	Dolichos	„	1,396	
14	Dolichos dug in December 1st	„	1,401	− 95
15	Dolichos	„	1,597	
16	Weeds	„	990	− 464
17	Dolichos	„	1,412	
18	Weeds cultivated December 1st and January 1st	„	1,240	− 172
19	Dolichos	„	1,412	
20	Dolichos	„	1,674	Non-experimental.
	Average		1,357	

Variety Lagos White—sown April 11th, 1927, supplied April 21st, singled to 1 per stand May 21st, harvested August 15th, 1927.

Ridges 6′ stands 18″ apart.

Each plot 0·18 acres.

Root-mean-square-difference between neighbouring control plots = 280 lb. per acre.

Average of 10 plots following Dolichos 1,357.

„ difference of 2 plots following Canavalia ... −225±199

„ „ 2 „ „ Mucuna ... − 92±199

„ „ 2 „ „ Cowpeas ... −123±199

„ „ 1 plot following Dolichos dug in on December 1st ... − 95±280

„ „ 1 plot after weeds (not cultivated)... −464±280

„ „ 1 plot after weeds cultivated on December 1st and January 1st −172±280

Ridged January 27th to 31st.

Weeded February 28th, March 1st, April 8th, 9th and 26th, May 20th, June 6th 22nd, July 13th and August 12th.

Cost of cultivations for above acreage 356 man days.

TABLE No. 2.

Dry Season Treatment of Cover Crop, 1927.

Plot.	Late Season Treatment.	Crop.	Yield of dry grain in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block B7, 8.				
1	Cover Crop dug in November ...	Maize	1,148	
2	Cover Crop dug in March ...	„	1,848	+ 226
3	Cover Crop dug in November ...	„	1,796	
4	Cover Crop dug in March ...	„	1,672	− 18
5	Cover Crop dug in November ...	„	1,784	
6	Cover Crop dug in March ...	„	1,836	+ 70
7	Cover Crop dug in November ...	„	1,748	
8	Cover Crop dug in March ...	„	1,500	− 160
9	Cover Crop dug in November ...	„	1,572	
10	Cover Crop dug in March ...	„	1,578	− 30
11	Cover Crop dug in November ...	„	1,664	
12	Cover Crop dug in March ...	„	1,464	− 132
13	Cover Crop dug in November ...	„	1,528	
14	Cover Crop dug in March ...	„	1,392	− 228
15	Cover Crop dug in November ...	„	1,712	
16	Cover Crop dug in March ...	„	1,468	− 198
17	Cover Crop dug in November ...	„	1,620	
	Average		1,652	− 60 ± 59

Variety Lagos White—Cover Crop Mucuna—sown April 4th, 1927, supplied 20th, singled May 3rd—Harvested 10th August, 1927.

Each plot $\frac{1}{4}$ acre. Ridges 6 feet, stands 18 inches apart.

Root—mean—square—difference between neighbouring control plots 168 lb. per acre.

Ridged March 8th.

Weeded March 30th, April 13th, May 5th and 30th, June 10th, August 9th.

Cost of cultivation for above experiment 345 man days.

TABLE No. 3.

TREATMENT OF COVER CROP EXPERIMENT, 1927.

Plot.	Late Season Treatment.	Crop Maize after Mucuna.	Yield of dry grain in lb. per acre.	Increase (+) or Decrease (−) compared with mean of adjacent controls.
C5N. 1	Non-experimental	Maize		
2	Cover crop burnt, February and dug in	,,	1,684	
3	Cover crop burnt, February and moulded up	,,	1,620	+ 88
4	Cover crop burnt, February and dug in	,,	1,480	
5	Cover crop burnt, February and moulded up	,,	1,520	− 6
6	Cover crop burnt, February and dug in	,,	1,572	
7	Cover crop burnt, February and moulded up	,,	1,568	+ 72
8	Cover crop burnt, February and dug in	,,	1,420	
9	Cover crop burnt, February and moulded up	,,	1,672	+ 242
10	Cover crop burnt, February and dug in	,,	1,440	
	Average		1,523	+ 99 ± 67

Root—mean—square—difference between neighbouring control plots 135 lb. per acre.

11	Cover crop cut in November dug in November	Maize	1,440	
12	Cover crop cut in November dug in March	,,	1,640	+ 8
13	Cover crop cut in November dug in November	,,	1,824	
14	Cover crop cut in November dug in March	,,	1,300	−532
15	Cover crop cut in November dug in November	,,	1,840	
16	Cover crop cut in November dug in March		1,600	− 74
17	Cover crop cut in November dug in November	,,	1,508	
18	Cover crop cut in November dug in March	,,	1,448	− 78
19	Cover crop cut in November dug in November	,,	1,544	
20	Non-Experimental	,,		
	Average		1,631	− 169 ± 128

Root—mean—square—difference between neighbouring control plots 255.
¼ acre plots—sown 5th April, 1927—harvested 11th August, 1927.
Supplied 20th April, singled 3rd May ; stands 18″ apart ; 6′ ridges.
Ridging, March 8th and 9th.
Weeding, April 4th, 14th, 29th, May 20th June 1st, 20th, July 12th, August 10th.
Cost of cultivation for above experiment. 447 man days.

TABLE No. 4.

Green Manuring Experiment, 1927.

Plot.	Early Season Treatment.	Crop.	Yield of dry grain in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block B3E.				
1	Mucuna	Late Maize	1,167	
2	Dolichos ...	„	1,167	− 23
3	Mucuna	„	1,214	
4	Canavalia ...	„	1,146	− 80
5	Mucuna	„	1,238	
6	Cowpeas ...	„	1,386	+108
7	Mucuna	„	1,319	
8	Dolichos ...	„	1,494	+105
9	Mucuna	„	1,459	
10	Canavalia ...	„	1,335	−141
11	Mucuna	„	1,493	
12	Cowpeas ...	„	1,365	+184
13	Mucuna	„	1,606	
	Average		1,356	

Variety Lagos white—sown September 2nd, 1927, supplied September 15th, singled September 23rd; Stands 18″ apart—harvested January 6th, 1928.

Eeach plot $\frac{1}{4}$ acre.

Root—mean—square—difference between neighbouring control plots 85 lb. per acre.

Average of seven plots following Mucuna 1,356

do. difference of two plots following Dolichos ... ... + 41±60

do. do. of two do. Canavalia ... .. −110±60

do. do. of two do. Cowpeas ... ... − 38±60

Ridged August 5th, 6′ ridges.

Weeding March 28th, April 22nd, May 11th, June 20th, September 26th, October 10th, November 2nd.

Cost of cultivation for above experiment 257 man days.

TABLE No. 5.

MANURIAL EXPERIMENT, 1927.

Plot.		Treatment.	Crop.	Yield of dry grain in lb. per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.
A3N	1	No Manure	Early Maize	828		
	2	N_2 ...	,,		1,180	+ 300
	3	No Manure	,,	932		
	4	P_2O_5 ...	,,		732	− 134
	5	No Manure	,,	804		
	6	N_2 & P_2O_5	,,		1,164	+ 206
	7	No Manure	,,	1,112		
	8	N_2 ...	,,		1,136	− 138
	9	No Manure	,,	884		
	10	P_2O_5 ...	,,		840	− 18
	11	No Manure	,,	832		
	12	N_2 & P_2O_5	,,		920	+ 120
	13	No Manure	,,	768		
		Average		880		

Root—mean—square—difference between neighbouring controls 172 lb. per acre.

A3S	14	No Manure	Early Maize	1,680		
	15	N_2 ...	,,		1,664	+ 138
	16	No Manure	,,	1,404		
	17	P_2O_5 ...	,,		1,388	− 46
	18	No Manure	,,	1,464		
	19	N_2 & P_2O_5	,,		1,428	− 152
	20	No Manure	,,	1,696		
	21	N_2 ...	,,		1,448	− 192
	22	No Manure	,,	1,584		
	23	P_2O_5 ...	,,		1,588	+ 74
	24	No Manure	,,	1,444		
	25	N_2 & P_2O_5	,,		1,880	+ 328
	26	No Manure	,,	1,680		

Root—mean—square—difference between neighbouring controls 192 lb. per acre.

¼ acre plots planted, April 11th, 1927, harvested August 15th, 1927, supplied May 2nd, singled to 18" May 21st.

A3N.—Average of seven unmanured plots 880
,, difference of two plots manured with cotton seed ... ... +219±122
,, ,, two ,, ,, ,, phosphate ... ... − 76±122
,, ,, two ,, ,, ,, both ... ... +163±122

A3S. ,, of seven unmanured plots 1,565
,, difference of two plots manured with cotton seed ... ... − 27±136
,, ,, two ,, ,, ,, phosphate ... ... + 14±136
,, ,, two ,, ,, ,, both ... ... + 88±136

Ridging—6' ridges, April 9th.
Weeding, April 28th, May 20th, June 6th, July 1st and 28th.
Cost of cultivation for above experiment 371 man days.

TABLE No. 6.

MANURIAL EXPERIMENT, 1927.

Plot.	Treatment.	Crop.	Yield of dry grain in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
A3N 1	No Manure	Late Maize	640	
2	N_2	„	1,272	+ 662
3	No Manure	„	580	
4	P_2O_5	„	416	— 106
5	No Manure	„	464	
6	N_2 and P_2O_5 ...	„	1,100	+ 578
7	No Manure	„	580	
8	N_2	„	928	+ 402
9	No Manure	„	472	
10	P_2O_5	„	428	− 66
11	No Manure	„	516	
12	N_2 and P_2O_5 ...	„	972	+ 458
13	No Manure	„	512	
	Average		538	
	Root—mean—square—difference of neighbouring controls 86 lb. per acre.			
A3S 14	No Manure	Late Maize	912	
15	N_2	„	1,392	+ 384
16	No Manure	„	904	
17	P_2O_5	„	764	− 100
18	No Manure	„	824	
19	N_2 and P_2O_5 ...	„	1,340	+ 368
20	No Manure	„	1,120	
21	N_2	„	1,308	+ 238
22	No Manure	„	1,020	
23	P_2O_5	„	856	— 144
24	No Manure	„	980	
25	N_2 and P_2O_5 ...	„	1,324	+ 133
26	No Manure	„	992	
	Average		965	

Root—mean—square—difference between neighbouring controls 94 lb. per acre.
¼ acre plots. Planted September 2nd, 1927—Harvested December 19th, 1927.
Variety Lagos White supplied September 15th, singled to 18" September 23rd.

A3N.	Average of 7 unmanured plots	538
	„ difference of 2 plots manured with cotton seed ...	+532±61
	„ „ „ 2 „ „ „ phosphate ...	− 86±61
	„ „ „ 2 „ „ „ both	+518±61
A3S.	„ of 7 unmanured plots	965
	„ difference of 2 plots manured with cotton seed ...	+311±94
	„ „ „ 2 „ „ „ phosphate ...	−122±94
	„ „ „ 2 „ „ „ both	+353±94

Ridging August 22nd 6' ridges.
Weeding September 15th, 27th, October 12th and November 3rd.
Cost of cultivation in man days = 316 man days.

TABLE No. 7.

EARLY MAIZE—RIDGING *versus* MOULDING UP, 1927.

Plot.		Early Season Treatment.	Crop.	Yield of dry grain lb per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
C3	1	Ridged	Maize	860	
	2	Moulded up	,,	1,192	+288
	3	Ridged	,,	948	
	4	Moulded up	,,	940	+ 56
	5	Ridged	,,	820	
	6	Moulded up	,,	816	−114
	7	Ridged	,,	1,040	
	8	Moulded up	,,	1,124	+ 14
	9	Ridged	,,	1,180	
	10	Moulded up	,,	1,300	+102
	11	Ridged	,,	1,016	
	12	Moulded up	,,	1,376	+320
	13	Ridged	,,	1,096	
	14	Moulded up	,,	1,224	+114
	15	Ridged	,,	1,124	
	16	Moulded up	,,	1,148	+106
	17	Ridged	,,	960	
	18	Moulded up	,,	1,056	+ 68
	19	Ridged	,,	1,016	
	20	Moulded up	,,	1,104	+ 62
	21	Ridged	,,	1,068	
	22	Moulded up	,,	1,068	+ 10
	23	Ridged	,,	1,048	
	24	Moulded up	,,	1,056	+ 76
	25	Ridged	,,	912	
	26	Moulded up	,,	1,240	+114
	27	Ridged	,,	1,140	
	28	Moulded up	,,	1,012	− 78
	29	Ridged	,,	1,040	
	30	Moulded up	,,	920	−172
	31	Ridged	,,	1,144	
	32	Moulded up	,,	796	−312
	33	Ridged	,,	1,072	
	34	Moulded up	,,	1,056	− 4
	35	Ridged	,,	1,048	
	36	Moulded up	,,	1,040	− 24
	37	Ridged	,,	1,080	
	38	Moulded up	,,	1,088	− 48
	39	Ridged	,,	1,192	
	40	Moulded up	,,	1,024	
		Average		1,040	+ 30

Variety Lagos White

¼ acre plots sown April 7th, 1927, supplied April 20th, singled to 18" May 21st.—Harvested August 8th, 1927.

Root—mean—square—difference between neighbouring controls 119 lb. per acre.

Average yield of 20 plots ridged up ... 1,040

,, difference of 19 plots moulded up 30 ± 27

Ridging March, 29th 6' ridges. Moulded up April 7th.

Weeding April 30th, May 3rd, 20th, June 4th and 23rd.

Cost of cultivation 461 man days.

TABLE No. 8.

Late Maize Spacing Test, 1927.

Plot.	Treatment.	Crop.	Yield of dry grain in lb. per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.
A7 1	Planted at 2′	Maize	1,400		
2	,, 1′ ...	,,		1,580	+ 66
3	,, 2′	,,	1,628		
4	,, 1½′ ...	,,		1,456	− 70
5	,, 2′	,,	1,416		
6	,, 2½′ ...	,,		1,104	−274
7	,, 2′	,,	1,340		
8	,, 3′ ...	,,		1,032	−302
9	,, 2′	,,	1,328		
10	,, 1′ ...	,,		1,332	+ 38
11	,, 2′	,,	1,260		
12	,, 1½′ ...	,,		1,420	+100
13	,, 2′	,,	1,380		
14	,, 2½′ ...	,,		1,392	− 46
15	,, 2′	,,	1,496		
16	,, 3′ ...	,,		1,040	−448
17	,, 2′	,,	1,480		
18	,, 1′ ...	,,		1,560	+202
19	,, 2′	,,	1,236		
20	,, 2′ ...	,,	(1,248)		Non-experimental.
21	,, 2′	,,	1,292		
22	,, 1½′ ...	,,		1,284	+ 9
23	,, 2′	,,	1,256		
24	,, 2½′ ...	,,		1,236	− 24
25	,, 2′	,,	1,264		
26	,, 3′ ...	,,		920	−296
27	,, 2′	,,	1,168		
28	,, 1′ ...	,,		1,144	+ 28
29	,, 2′	,,	1,064		
30	,, 1½′ ...	,,		1,228	+134
31	,, 2′	,,	1,124		
32	,, 2½′ ...	,,		1,168	+ 66
33	,, 2′	,,	1,080		
34	,, 3′ ...	,,		828	−262
35	,, 2′	,,	1,100		
36	,, 1½′ ...	,,		1,252	+ 82
37	,, 2′	,,	1,240		
38	,, 2½′ ...	,,		1,172	− 4
39	,, 2′	,,	1,112		
40	,, 2′ ...	,,	(896)		Non-experimental.
	Average		1,220		

Variety Lagos White—Sown September 5th, 1927, supplied September 15th, singled to 18″ September 27th—harvested January 16th, 1928.

Root—mean—square—difference between neighbouring control plots 119 lb. per acre.

Average of 20 plots at 2′ ...		1,220
,, difference of 4 plots at 1′		+ 83 ± 59
,, ,, ,, 5 ,, ,, 1½′		+ 51 ± 53
,, ,, ,, 5 ,, ,, 2½′		− 56 ± 53
,, ,, ,, 4 ,, ,, 3′		−327 ± 59

Ridging August 19th, 6′ ridges.
Weeding September 28th, October 11th and 28th and November 24th.
Cost of cultivations. 523 man days.

TABLE No. 9.

YAM VARIETIES, 1927.

Plot.	Variety.	Crop.	Yield of tubers in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
D5N 1	Iyawo	Yams	8,200	
2	Alade	„	6,952	− 566
3	Iyawo	„	6,836	
4	Odo	„	7,436	− 380
5	Iyawo	„	8,796	
6	Esinmirin ...	„	11,016	+ 2,334
7	Iyawo	„	8,368	
8	Alade	„	6,424	− 1,770
9	Iyawo	„	8,020	
10	Odo	„	4,996	− 3,228
11	Iyawo	„	8,428	
12	Esinmirin ...	„	9,380	+ 1,222
13	Iyawo	„	7,888	
14	Alade	„	6,024	− 2,012
15	Iyawo	„	8,184	
16	Odo	„	6,748	− 2,486
17	Iyawo	„	10,284	
18	Esinmirin ...	„	9,256	+ 226
19	Iyawo	„	7,776	
20	Iyawo	„	(7,648)	Non-experimental.

Each plot $\frac{1}{4}$ acre—Planting distance, 20″.

Yams sown January 27th, 1927—harvested January 18th, 1928.

Root—mean—square—difference between neighbouring control 1,384 lb. per acre.

Average yield of 10 plots,	Iyawo	... ...	8,278
„ difference of 3 plots,	Alade	... ...	−1,449±800
„ „ „ 3 „	Odo	... ...	−2,031±800
„ „ „ 3 „	Esinmirin	... ...	+1,261±800

Ridging. November 17th–22nd, 1926.

Weeding. December 29th, 1926, February 11th, 17th, March 19th, May 10th, 31st, June 27th, July 11th.

Cost of cultivation in man days—612.

TABLE No. 10.

Coconuts, 1927.

Plot.	Area.	Planting Distance.	No. of trees at end of year.			Vacancies.	No. of collections.	Yield.			
			Bearing.	Non-bearing.	Young Plants.			Good.	Bad.	Total.	% Bad.
B1	5	30′ × 30′	163	30	6	15	7	18,123	2,942	20,065	14·7
C1	5	25′ × 25′	174	106	14	15	7	8,889	2,998	11,887	25·2

TABLE No 11.

Coffee, 1927.

Planted 12′ × 12′ in 1925.

Plot.	Variety.	Area.	Yield of fresh berries per plot in lb.	Yield of parchment coffee per plot in lb.	Yield of parchment coffee in lb. per acre.
A. 2 SE. ...	Abeokuta ...	1 acre	1,422	512	512

TABLE No. 12.

Kola (Gbanja), 1927.

2½ acres. Planted 15′ × 15′ in 1913.

Plot.	No. of collections.	No. of pods.	Weights of pods.	No. of Nuts, good or bad.	Weights of good nuts.	Yield of nuts in lb. per acre.
Y5	18	1,319	742 lb.	7,129	273 lb.	109

TABLE No. 13.

Oil Palm (Wild) 1927.

Block.	Treatment.	Acreage.	No. of collections.	No. of trees from which collected.	Total No. of bunches.	Total weight of bunches. lb.	Weights of bunches per bearing palm.	Weights of bunches per acre.	Average weight per bunch.
									lb.
A6 y	Cultivated	2½	17	51	194	4,765	93·4	1,906	24·6
A6 a	Uncultivated	2½	18	71	325	7,440	104·8	2,976	22·9
Z6 x	Uncultivated	2	13	49	111	1,176	24·0	588	10·6
Z6 b	Cultivated	3	16	59	304	6,735	114·1	2,245	22·1

TABLE No. 14.

Palm Tapping, 1927.

No. of trees.	No. of periods.	Total No. of days in the periods.	Yields of Wine in gallons.	Yield of Wine 1917–1927 in gallons.	Remarks.
1	...	...	...	72·94	Felled 1922.
2	2	15	1·74	111·33	Yielded for two years only.
3	...	...	...	28·65	do.
4	...	...	...	29·60	do.
5	...	...	...	19·52	Yielded in 1925.
6	...	...	...	27·34	
7	3	75	10·20	118·39	
8	...	...	...	41·09	Yielded for four years only.
9	4	64	5·20	33·936	
10	3	25	8·57	64·83	

TABLE No. 15.

Cost of Cultivation of main Crops—1927.

Figures in man-day per acre, obtained from plots of the Main Rotation.

Crop.	Preparation.	Establishing.	After cultivation.	Harvesting.	Store work.	Total.	
Yams	23	42	39	26	5	135	
Green Manure and	46	13	29	...	...	88	214
Cotton	56	8	50	12	...	126	
Groundnuts and ...	18	10	40	35	9	112	130
Cover Crop ...	6	2	7	3	..	18	
Maize and	26	5	10	4	15	60	75
Cover Crop ...	3	3	8	1	...	15	
Late Maize	26	3	17	8	4	58	

The reason for high initial cost of establishing the groundnut crop is that it was attacked by Sclerotium Rolfsii and this necessitated a gang of boys going over the field every morning uprooting attacked plants until the outbreak was checked.

TABLE No. 16.

Comparison of costs of Production and Revenue for Main Rotation Crops, 1927–28 season, Moor Plantation.

Cost of labour 1s. per man-day.

Crops.	Cost of Crops in man-days per acre.	Average yield in lb. per acre.	Cost of production of crop in man-days per lb.	Market value per lb. at store.	Calculated return per acre.	Monetary return per man-day.	Kind of Crop.
Yams. *Gross ...	135	8,278	·0163	·428d.	3,550d.	26·5d.	Tubers.
Nett ...	135	5,491	·0246	·428d.	2,350d.	17·40d.	,,
Cotton	126	75	1·68	1·18d.	88d.	0·70d.	Seed cotton.
Groundnuts ...	112	1,086	·103	·910d.	987d.	8·81d.	Undecorticated.
Early Maize ...	60	1,208	·050	† ·536d.	647d.	10·78d.	Dry grain.
Late Maize ...	58	1,220	·048	·750d.	915d.	15·78d.	,,

Both the gross and the nett returns are shown for yams; for other crops only the gross return as the value of the seed is inappreciable compared with that of the yield.

* Nett yield of yams represents the total tubers harvested less the weight of seed-tubers planted.

† Price above the average owing to short crop.

ANNUAL REPORT, AGEGE, 1927

BY

H. G. Poynter.

Kola (Table No. 1).

The yields of kola for the past years are given below. That for 1927 is very much lower than in previous years and is probably due to the very bad season when the lack of rain at the period when it was most required caused not only a lower yield but a very large proportion of small nuts.

Season.	Yield of good nuts in lb. per acre.
1922	716.
1923	532.
1924	546.
1925	838.
1926	424.
1927	107.

The weight of small nuts this year was very high in proportion the figure being 120 lb. per acre.

Cocoa (Table No. 2).

The average yield was only 128 lb. of dry cocoa per acre, equivalent to 1.12 lb. per tree as against 3½ lb. recorded last year. A large number of trees died during the year and although the actual number of bearing trees was maintained, it was done by young ones coming into bearing for the first time; this, coupled with a bad season, accounts for the very low yield compared with previous years.

Drought was largely responsible for the loss of most of the older trees mentioned above, the comparatively shallow soil at Agege drying out very badly.

Cocoa—Sixteen Acres Planted 1910.

Season.	Yield of dry cocoa lb. per acre.
1922	314.
1923	490.
1924	362.
1925	306.
1926	339.
1927	128.

Comparison between Costs of Kola and Cocoa.

	Cocoa, 16 acres.			Kola, 7 acres.		
Average yield per acre	128 lb.			107 lb.		
	£	s.	d.	£	s.	d.
Average price per ton	50	10	0	21	6	8
„ gross revenue per acre ...	2	17	8	1	0	4
„ cost of labour per acre ...	2	1	3	1	2	0
„ profit	0	16	5	0	1	8
Labour in man-days per acre ...	45			24		
Cost per man-days	11d.			11d.		
Gross return per man-day	1s. 3d.			10d.		

The average yield per acre of good kola nuts was 2,105; the average number of nuts in one pound was eighteen; the price per 100 good nuts was 1s. 1d. and the price per pound 2¼d.

The average yield of inferior nuts was 6,480 or 120 lb. per acre, this being additional return and not shown in the above table. As a rule kola pays better at Agege than cocoa but this year the reverse has been the case owing to the higher price of cocoa and the very poor yield of first grade kola nuts, the yield of small nuts per acre being four times as great as last year.

H. G. POYNTER,
Supt. of Agriculture.

TABLE No. 1.

Kola (Variety—Gbanja) Yields for 1927.

All Plots Planted in 1911.

Plot No.	Acreage.	Original spacing.	No. of trees per plot.		Yield of good nuts.	
			Bearing.	Non-bearing.	lb. per acre.	lb. per bearing tree.
B1	2	15′ × 15′	150	7	170	2·25
B2	2	20′ × 20′	150	37	131	1·74
D1	2	15′ × 15′	101	43	54	1·07
D2	1	20′ × 20′	50	31	39½	·8
	...	...	451	118	107	1·46

TABLE No. 2.

Cocoa Yields for Season 1927.

All Plots Originally Planted out in 1910.

Plot No.	Acreage.	Variety.	Original spacing square.	No. of bearing trees per plot.	Yield of Dry Beans.	
					lb. per acre.	lb. per bearing tree.
A1	2·0	Yellow Pod ...	12′	240		...
A2	2·0	„ „ ...	15′	193		...
A3	2 0	„ „ ...	12′	310	Individual	...
A4	2·0	„ „ ...	15′	188	plot records	...
C1	2·0	Red Pod ...	12′	309	not recorded	...
C2	2·0	„ „ ...	15	201	this season.	...
C3	2·0	„ „ ...	12′	250		...
C4	2·0	„ „ ...	15′	140		...
	16·0		...	1,831	2,052	1·12

ANNUAL REPORT—OGBA STATION, BENIN, SOUTHERN PROVINCES, 1927

BY

G. W. LINES, B.A.

The following results of experiments were obtained during 1927.

1.—COVER CROP EXPERIMENTS.

First figures have been obtained from experiments started in 1926.

(a) Dolichos versus Mucuna—Test Crop Early Maize. Table No. 1.

There is no appreciable difference in the yield of early maize grown after a crop of late mucuna as compared with the yield of early maize grown after a late crop of dolichos.

	Maize cobs lb. per acre.	"Odds" that difference is significant.
Average yield of 5 plots following mucuna	1,242	—
Average difference of 4 plots following Dolichos	−19±194	less than 2 : 1

(b) Treatment of Cover Crop—Test Crop Early Maize. Table No. 2.

The yield of maize throughout was uniformly poor owing to faulty germination and bad soil. The figures obtained are in favour of cutting and digging in mucuna rather than burning mucuna before digging in.

	Maize cobs lb. per acre.	"Odds" that difference is significant.
Average yield 5 plots burnt and dug in March	414	—
Average difference 4 plots cut and dug in March	+157±96	17 : 1

(c) Mucuna once sown versus *Mucuna twice sown—Test Crop.*

(a) Early Maize. (b) Late Maize. Table 3.

This experiment was started in 1926 to compare mucuna sown in March and left throughout the rainy and dry seasons as against mucuna sown in March dug in at greatest bulk in July and resown immediately with a second crop of mucuna which will grow

throughout the dry season. An early and a late crop of maize were grown in 1927 as test crops. The two results show figures in favour of the single crop of mucuna. The experiment is being continued in 1928.

	Maize cobs lb. per acre.	Odds that difference is significant.
(*a*) *Early maize.*		
Average yield 5 plots following Mucuna once sown	1,686	—
Average difference 4 plots following mucuna twice sown	−143±77	27 : 1
(*b*) *Late maize.*		
Average yield 5 plots following mucuna once sown	494	—
Average difference 4 plots following mucuna twice sown	−59±48	8 : 1

(d) Green Manuring Experiment—Test Crop Late Maize.

Table No. 4.

Previous figures with yams as test crop have been slightly in favour of crotolaria although the figures have not been significant. The experiment was repeated this year with late maize instead of yams as test crop. There is no significant difference in yield in any of the treatments.

	Maize cobs lb. per acre.	"Odds" that difference is significant.
Average yield 13 plots following Dolichos	941	—
Average difference of 4 plot following Centrosema	+17±104	less than 2 : 1
Average difference 4 plots following Crotolaria	+ 7±104	
Average difference 4 plots following Mucuna	+34±104	

2.—Cassava Exhaustion Experiment—Test Crop Yams.

Table No. 6.

This experiment was started in 1925 with the object of studying the effect of cassava on soil fertility. Five standard plots have had two crops of maize alternating with two crops of mucuna beans and have had three ridgings since 1925. Four treatment plots have had one crop of maize followed by a crop of casava standing for two years and then a crop of mucuna since 1925. These four plots have received only two ridgings in that time. In 1927 a test crop of yams was grown throughout. The yield of yams shows a definite increase from those plots on which cassava has been grown previously. A possible explanation of this is that the cassava tops were cut and

buried in the soil. The food material thus brought back to the soil together with the effect the buried cassava tops had on the texture of the soil may be the causes of this very marked increase in yield of yams.

	Yams lb. per acre.	"Odds" that difference is significant.
Average yield of 5 standard no cassava plots	6,183	—
Average difference of 4 plots with cassava	+3,127 ± 314	00 : 1

3.—Native Farming *versus* Continuous Farming. Table No. 7.

This experiment is a triplication, started in 1927, of two other blocks treated identically but started in different years, *i.e.*, 1925 and 1926. Nine control plots are treated in standard native fashion whilst four unstumped plots and four stumped plots are farmed on a rotation and cultivated in six feet ridges. In 1925 results were inconclusive, in 1926 definitely increased yields were obtained from the ridged continuously farmed plots. In 1927 the results are again inconclusive.

All these figures show yields obtained in the first year of clearing bush whether on the native farmed plots or on the rotated plots. It is not likely therefore that any striking differences will show themselves yet.

	Yams lb. per acre.	"Odds" that difference is significant.
Average yield 9 standard Native Practice plots	6,637	—
Average difference 4 stumped and Ridged plots	+ 99 ± 735	less than 2 : 1
Average difference 4 unstumped and Ridged plots	−569 ± 735	

Permanent Crops.

There are sharp distinctions in the soils of Benin Province and their ability to grow various permanent crops. The farm soil is of a poor sandy type in which oil palms, coffee, para rubber and high bush trees grow fairly well. Kola grows but not as successfully as it should do and cocoa has definitely failed to grow except in a few instances. This experience is general in the immediate district. This is reflected in the permanent crop experiments on the farm. Oil palms in all cases have made good growth, coffee has grown well and cocoa has been difficult to establish. The Intercropping of Oil Palms experiment is showing definite results as indicated in Table No. 5. Other permanent crop experiments have not reached the stage at which figures can be obtained.

Oil Palms.—Intercropping Experiment.

Test Crop.—(a) Yams Table No. 5.

(b) Late Maize. Table No. 5.

In 1925 and 1926 intercrops were taken from plots containing thirty-three and twenty-one palms per acre respectively and no definite decrease in yield was obtained compared with those plots having nil palms per acre. In 1927 definite decreases show in the palm plots. As the palms grow further these differences should become still more marked.

(*a*)

	Yams lb. per acre.	"Odds" that difference is significant.
Average yield 3 plots with nil palms per acre	5,039	—
Difference 1 plot with 33 palms per acre	−572±290	43 : 1
Difference 1 plot with 21 palms per acre	−869±290	740 : 1

(*b*)

	Maize cobs lb. per acre.	Odds that difference is significant.
Average yield 3 plots with nil palms per acre	842	—
Difference 1 plot with 33 palms per acre	−190±59	1,448 : 1
Difference 1 plot with 21 palms per acre	−166±59	390 : 1

G. W. LINES,

Superintendent of Agriculture.

TABLE No. 1.

Mucuna *versus* Dolichos—Test Crop Early Maize.

Plot No.	Treatment.	Yield in lb. cobs per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.
W. 21	Mucuna	1.504		
22	Dolichos ...		1,424	− 102
23	Mucuna	1,548		
24	Dolichos ...		1,420	+ 206
25	Mucuna	880		
26	Dolichos ...		784	− 270
27	Mucuna	1,228		
28	Dolichos ...		1,228	+ 90
29	Mucuna	1,048		

R = 388.

Average yield 5 control plots following Mucuna 1,242 lb. per acre.

Average difference 4 plots following Dolichos — 19 ± 194.

Maize planted 5th March, 1927. Harvested 18th July, 1927.

Each plot ¼ acre.

TABLE No. 2.

Treatment of Cover Crop Experiment—Test Crop Early Maize.

Plot No.	Treatment.	Yield in lb. cobs per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.
Y. 40	Mucuna burnt ...	684		
41	Mucuna cut ...		620	+ 100
42	Mucuna burnt ...	356		
43	Mucuna cut ...		524	+ 152
44	Mucuna burnt ...	388		
45	Mucuna cut ...		436	+ 32
46	Mucuna burnt ...	420		
47	Mucuna cut ...		688	+ 346
48	Mucuna burnt ...	224		

R = 192.

Average yield 5 plots burnt in March and dug in 414 lb. per acre.

Average difference 4 plots cut in March and dug in + 157 ± 96.

Maize planted 8th March, 1927. Harvested 26th July, 1927.

Each plot ¼ acre.

TABLE No. 3.

(*a*) Mucuna once sown *versus* twice sown—Test Crop Early Maize.

Plot. No.	Treatment.	Yield in lb. cobs per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Y. 31	Mucuna once sown ...	1,460	
32	Mucuna twice sown ...	1,380	− 150
33	Mucuna once sown ...	1,600	
34	Mucuna twice sown ...	1,728	+ 2
35	Mucuna once sown ...	1,852	
36	Mucuna twice sown ...	1,660	− 174
37	Mucuna once sown ...	1,816	
38	Mucuna twice sown ...	1,508	− 252
39	Mucuna once sown ...	1,704	

R = 155.

Average yield of 5 plots following Mucuna once sown—1,686 lb. per acre.

Average difference of 4 plots following Mucuna twice sown − 143 ± 77.

Maize planted 5th March, 1927. Harvested 18th July, 1927.

(*b*) Mucuna once sown *versus* twice sown—Test Crop Late Maize.

Plot No.	Treatment.	Yield in lb. cobs per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Y. 31	Mucuna once sown ...	564	
32	Mucuna twice sown ...	448	− 70
33	Mucuna once sown ...	472	
34	Mucuna twice sown ...	440	− 82
35	Mucuna once sown ...	572	
36	Mucuna twice sown ...	512	− 14
37	Mucuna once sown ...	480	
38	Mucuna twice sown ...	360	− 70
39	Mucuna once sown ...	380	

R = 96.

Average yield of 5 plots following Mucuna once sown—494 lb. per acre.

Average yield of 4 plots following Mucuna twice sown − 59 ± 48.

Maize planted 7th September, 1927. Harvested 10th January, 1928.

Each plot $\frac{1}{4}$ acre.

TABLE No. 4.

Green Manuring Experiment—Test Crop late Maize.

Plot No.	Treatment.	Yield in lb. cobs per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Z. 46	Dolichos	1,128	
47	Centrosema	1,040	− 156
48	Dolichos	1,264	
49	Crotolaria	1,004	− 50
50	Dolichos	844	
51	Mucuna	836	+ 30
52	Dolichos	768	
53	Centrosema	904	+ 192
54	Dolichos	656	
55	Crotolaria	912	+ 212
56	Dolichos	744	
57	Mucuna	892	+ 38
58	Dolichos	964	
59	Centrosema	904	− 52
60	Dolichos	948	
61	Crotolaria	984	− 142
62	Dolichos	1,304	
63	Mucuna	1,176	− 46
64	Dolichos	1,140	
65	Centrosema	1,144	+ 84
66	Dolichos	980	
67	Crotolaria	936	+ 10
68	Dolichos	872	
69	Mucuna	864	+ 116
70	Dolichos	624	

R = 209.

Average yield 13 plots following Dolichos 941 lb. per acre.

Average difference 4 plots following Centrosema + 17 ± 104

Average difference 4 plots following Crotolaria + 7 ± 104

Average difference 4 plots following Mucuna + 34 ± 104

Maize planted 3rd September, 1927. Harvested 31st December, 1927.

Each plot $\frac{1}{4}$ acre.

TABLE No. 5.

(*a*) Intercropping of Palms—Test Crop Yams.

Plot No.	Treatment.	Yams yield in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Q 1	No palms per acre	5,069	
2	33 palms per acre	4,570	− 572
3	No palms per acre	5,216	
4	21 palms per acre	4,155	− 869
5	No palms per acre	4,833	

R = 290.

Average yield 3 control plots with nil palms ... ... = 5,039 lb. per acre.

Difference of 1 plot with 33 palms ... ... = − 572 ± 290

Difference of 1 plot with 21 palms ... ... = − 860 ± 290

Yams planted 6th June, 1927. Harvested 11th January 1928.

(*b*) Intercropping of Palms—Test Crop Late Maize.

Plot No.	Treatment.	Maize yield in lb. cobs per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
P 1	No palms per acre	784	
2	33 palms per acre	635	− 190
3	No palms per acre	867	
4	21 palms per acre	705	− 166
5	No palms per acre	876	

R = 59.

Average yield 3 control plots with nil palms ... ... = 842 lb. per acre.

Difference of 1 plot with 33 palms ... ... = − 190 ± 59

Difference of 1 plot with 21 palms ... ... = − 166 ± 59

Maize planted 26th August, 1927. Harvested 28th December, 1927.

Size of plots in Block P and Q = 1 acre.

TABLE No. 6.

Cassava Exhaustion Experiment—Test Crop Yams.

No. of Plot.	Treatment.	Yield of yams in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Y 22	No Cassava	5,396	
23	Cassava	11,108	+ 5,116
24	No Cassava	6,588	
25	Cassava	8,336	+ 1,928
26	No Cassava	6,228	
27	Cassava	8,108	+ 1,802
28	No Cassava	6,384	
29	Cassava	10,016	+ 3,664
30	No Cassava	6,320	

R = 628.

Average yield of 5 standard no cassava plots ... ... 6,183 lb. per acre.

Average difference of 4 plots with cassava ... ... + 3,127 ± 314 lb.

Each plot = $\frac{1}{4}$ acre.

Yams planted 23rd May, 1928. Harvested 3rd January, 1928.

TABLE No. 7.

NATIVE FARMING *versus* CONTINUOUS CROPPING.

Plot No.	Treatment.	Yield of yams in lb. per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.
W 97	Native Practice	7,224		
98	Stumped and Ridged ...		6,432	+ 286
99	Native Practice	5,068		
100	Unstumped and Ridged ...		5,640	+ 126
101	Native Practice	5,960		
102	Stumped and Ridged ...		6,456	+ 536
103	Native Practice	5,880		
104	Unstumped and Ridged ...		6,420	− 382
105	Native Practice	7,724		
106	Stumped and Ridged ...		6,148	− 456
107	Native Practice	5,484		
108	Unstumped and Ridged ...		5,592	− 302
109	Native Practice	6,304		
110	Stumped and Ridged ...		6,900	− 32
111	Native Practice	7,432		
112	Unstumped and Ridged ...		6,324	− 1,720*
113	Native Practice	8,656		

R = 1,470.

Average yield 9 standard Native Practice Plots ... ... 6,637 lb. per acre.

„ difference (*a*) 4 Stumped and Ridged plots ... ... + 99 ± 735

„ „ (*b*) 4 Unstumped and Ridged plots ... ... − 569 ± 735

Each plot ¼ acre.

Yams planted 30th May, 1928. Harvested 5th January, 1928.

* The large figure here is due to the markedly increased yield in the end plot 113.

TABLE No. 8.

Cost of Cultivation of Main Annual Crops—1927.

Figures in man-days per acre obtained from Main Rotation blocks.

Crop.	Preparation.	Establishing.	After cultivation.	Harvesting.	Total.
1. Yams and	27	38	27	34	126
Cover Crop	—	1	—	—	1
2. Early Maize and ...	24	12	17	7	60
Cover Crop	9	6	17	2	34
3. Green Manure and ...	7	8	10	29	54
Late Maize	29	7	4	4	44

TABLE No. 9.

Comparison of Costs of Production and Revenue for Main Rotation Crop, 1927.

Cost of labour=10d. per man-day.

Crops.	Cost of crop in man-days per acre.	Average yield per acre lb.	Cost of production of crop in man-day per lb.	Market value per lb.	Calculated return per acre.	Gross Monetary return per man-day.	Kind of crop.
					£ s. d.		
Yams and Cover Crop	127	6,753	·0188	·428d.	12 0 10	22·75d.	Tubers.
Early Maize and Cover Crop ...	94	1,229	·0797	·321d.	1 12 10	4d.	Unhusked cobs.
Green Manure and Late Maize ...	98	953	·1028	·535d.	2 2 6	5d.	Unhusked cobs.

Rainfall 1927.

Experimental Farm, Benin.

Month.	Rainfall in inches.	Previous rainfall in inches.			
	1927.	19 6.	1925.	1924.	1923.
January	2·23	·15	...	·15	...
February	·64	1·93	1·29	2·82	·32
March	3·34	3·68	6·02	3·07	3·19
April	6·31	5·79	4·23	7·42	5·40
May	6·82	10·96	4·89	6·48	5·24
June	14·82	16·65	8·58	8·86	13·83
July	15·25	8·20	11·97	7·10	13·84
August	6·05	4·77	15·08	2·56	2·16
September	8·99	9·91	10·93	14·09	10·35
October	13·98	8·42	9·19	8·40	11·60
November	3·48	2·39	3·20	2·68	1·58
December	4·87	...	·24	·88	...
	86·78	72·85	75·66	64·51	67·51

Average 1923–27 inclusive = 75·462 inches.

ANNUAL REPORT, AGRICULTURAL STATION—UMUAHIA, 1927.

BY

S. M. GILBERT, B.SC., N.D.A.

Increased knowledge of local farming conditions is enabling the Staff to investigate several interesting points in regard to food crops.

ANNUAL FOOD CROPS.

The series of experiments, commenced in 1925, to compare farming on native lines exactly as against continuous cropping on (*a*) stumped and ridged (*b*) unstumped and ridged land is still proceeding. Once again there is no definite superiority in either method in the first year. *See* Tables 1 and 2.

NATIVE FARMING *versus* THAT ON RIDGED AND STUMPED AND RIDGED AND UNSTUMPED LAND.—TABLE NO. 1.

YAMS.

	Yield lb. per acre.	Odds that difference is significant.
Average yield 9 plots, Native Practice	4,602	—
Average yield 4 plots unstumped and ridged	−137±168	4 : 1
Average yield 4 plots stumped and ridged	−145±168	4 : 1

NATIVE FARMING *versus* THAT ON RIDGED AND STUMPED AND RIDGED AND UNSTUMPED LAND.—TABLE NO. 2.

MAIZE.

	Yields, dry grain lb. per acre.	Odds that difference is significant.
Average yield 9 plots native practice ...	574	—
Average yield 4 plots ridged and unstumped	+262 ± 65	33,330 : 1
Average yield 4 plots ridged and stumped	+185 ± 65	420 : 1

No useful conclusion can, of course, be drawn until the rotation commencing in 1925 is complete. This will be in 1931. In 1928, however, yams are being grown in experimental plots in the

Block begun in 1925 and an indication should then be obtained of the ability of that land to stay under continuous cultivation.

Comparison of various legumes followed by mucuna as preparation for maize gave most interesting results.

Ground nuts strengthened their position as one of the best crops to proceed maize. In addition the value of the small crop of ground nuts of 517lb. per acre must not be overlooked. *See* Table 5.

VARIOUS GREEN MANURES *versus* GROUND NUTS AS PREPARATION FOR MAIZE.

	Yields, dry grain lb. per acre.	Odds that difference is significant.
Average yield 13 plots maize following ground nuts and mucuna	837	—
Average difference 4 plots maize following Canavalia and Mucuna	− 93±90	6 : 1
Average difference 4 plots maize following mucuna and mucuna	− 89 ± 90	: 1
Average difference 4 plots maize following Pigeon peas and mucuna	−170 ± 90	34 : 1

The maize spacing experiment gave no conclusive result. *See* Table No. 6.

MAIZE—DISTANCE OF PLANTING.

	Yield of dry grain, lb. per acre.	Odds that difference is significant.
Average yield 9 plots with 1′ 6″ spacing	696	—
Average difference 4 plots with 2′ spacing	−155 ± 111	12 : 1
Average difference 4 plots with 9″ spacing	−147 ± 111	10 : 1

(*See* TABLE No. 6.)

OIL PALMS.

As was to be expected in the first year of such an experiment the yield of late maize in plots in which various densities of oil palms, about three years of age, were growing, was not affected. *See* Table No. 7.

EFFECT ON FARM LAND OF NIL OIL PALMS AND OIL PALMS IN VARYING FREQUENCY.

	Yields, dry grain lb. per acre	Odds that difference is significant.
Average yield of 5 plots nil Palms per acre	195	—
Average yield of 2 plots 21 palms per acre	−2·5 54	—
Average yield of 2 plots 33 palms per acre	−30 54	13 : 1

An interesting lesson was here apparent. The oil palms had been planted in clean weeded rides in the bush during 1925 in the land used for this experiment. In July, 1927, the bush was cutlassed and prepared for the above late maize. In this latter crop the former rides were indicated with almost mathematical exactness by a very much poorer stand of corn, which seems to drive home the old lesson that in the tropics the soil must be protected by a cover crop from sun and wash.

Probably the same reasons account for the results shown in Table No. 8.

In 1923 oil palms were planted out, two plots in stumped land which was cropped each year following, three plots in six feet rides in existing bush. Since 1926 the latter three plots have been brushed back periodically and the growth now does not form sufficient protection from sun and rain. None of the latter three plots have commenced bearing and the slower vegetative growth is equally striking. Both the experimental plots in stumped land are bearing. *See* Table No. 8.

S. M. GILBERT,
Superintendent.

TABLE No. 1.

Native Farming *versus* (*a*) that on Ridged and Stumped (*b*) Ridged and Unstumped Land.

Plot No.	Treatment.	Crop.	Yield lbs. per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.
Block Q 35–51		Yams.			
35	Native Practice—Unstumped ...	,,	3,960		
36	Unstumped and Ridged	,,		4,516	+ 176
37	Native Practice—Unstumped ...	,,	4,720		
38	Stumped and Ridged	,,		4,112	− 548
39	Native Practice—Unstumped ...	,,	4,600		
40	Unstumped and Ridged	,,		4,672	+ 108
41	Native Practice—Unstumped ...	,,	4,528		
42	Stumped and Ridged	,,		4,320	− 304
43	Native Practice—Unstumped ...	,,	4,720		
44	Unstumped and Ridged	,,		4,400	− 436
45	Native Practice—Unstumped ...	,,	4,952		
46	Stumped and Ridged	,,		4,612	− 180
47	Native Practice—Unstumped ...	,,	4,632		
48	Unstumped and Ridged	,,		4,320	− 396
49	Native Practice—Unstumped ...	,,	4,800		
50	Stumped and Ridged	,,		5,104	+ 450
51	Native Practice—Unstumped ...	,,	4,508		

Average ... 4,602 lb. per acre.

Each Plot ¼ acre. Yams planted 21st and 22nd March, harvested 11th and 12th October.

Variety :—Jike.

Increase (+) or Decrease (−) on Unstumped and Ridged Plots.

+ 176

+ 108

− 436

− 396

Average − 137 ± 168 lb. per acre.

Increase (+) or Decrease (−) on Stumped and Ridged Plots

− 548

− 364

− 180

+ 450

Average − 145 ± 168 lbs. per acre.

Root—Mean—Square difference between neighbouring Control Plots ... 336 lbs. per acre.

Germination :—

TABLE No. 2.

NATIVE FARMING *versus* (*a*) THAT ON RIDGED AND STUMPED, (*b*) RIDGED AND UNSTUMPED LAND.

Plot No.	Treatment.	Crop.	Yield of dry grain lbs. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block Q 35-51		Maize.		
35	Native Practice	„	340	
36	Unstumped and Ridged ...	„	740	+ 380
37	Native Practice	„	380	
38	Stumped and Ridged ...	„	724	+ 350
39	Native Practice	„	368	
40	Unstumped and Ridged ...	„	696	+ 310
41	Native Practice	„	404	
42	Stumped and Ridged ...	„	800	+ 252
43	Native Practice	„	692	
44	Unstumped and Ridged ...	„	892	+ 216
45	Native Practice	„	660	
46	Stumped and Ridged ...	„	824	+ 72
47	Native Practice	„	844	
48	Unstumped and Ridged ...	„	932	+ 144
49	Native Practice	„	732	
50	Stumped and Ridged ...	„	808	+ 68
51	Native Practice	„	748	

Average ... 574 lb. per acre.

Each Plot ¼ acre. Maize sown 2nd April, harvested 8th August.

Increase (+) or Decrease (−) in Ridged and Unstumped Plots.

+ 380 lb. per acre.
+ 310 „ „ „
+ 216 „ „ „
+ 144 „ „ „

Average + 262 ± 65 lb. per acre.

Increase (+) or Decrease (−) in Ridged and Stumped Plots.

+ 350 lb. per acre.
+ 252 „ „ „
+ 72 „ „ „
+ 68 „ „ „

Average + 185 ± 65 lb. per acre.

Root—Mean—Square difference between neighbouring Control Plots ... 129 lb. per acre.

TABLE No. 3.

GREEN MANURE *versus* GROUND NUTS AS PREPARATION FOR MAIZE.

Plot No.	Late season treatment.	Crop.	Yield per acre lbs. dry-grain.	Increase (+) or decrease (−) compared with mean of adjacent standards.
Block D 17–41		Maize.		
17	Ground Nuts– Mucuna	,,	684	
18	Canavalia—Mucuna	,,	492	− 180
19	Ground Nuts—Mucuna	,,	660	
20	Mucuna—Mucuna	,,	636	− 158
21	Ground Nuts– Mucuna	,,	928	
22	Pigeon Peas—Mucuna	,,	520	− 250
23	Ground Nuts—Mucuna	,,	612	
24	Canavalia—Mucuna	,,	488	− 156
25	Ground Nuts—Mucuna	,,	676	
26	Mucuna—Mucuna	,,	712	− 60
27	Ground Nuts—Mucuna	,,	868	
28	Pigeon Peas—Mucuna	,,	584	− 288
29	Ground Nuts—Mucuna	,,	876	
30	Canavalia—Mucuna	,,	920	− 118
31	Ground Nuts—Mucuna	,,	1,200	
32	Mucuna—Mucuna	,,	984	− 152
33	Ground Nuts—Mucuna	,,	1,072	
34	Pigeon Peas—Mucuna	,,	936	− 54
35	Ground Nuts—Mucuna	,,	908	
36	Canavalia—Mucuna	,,	964	+ 82
37	Ground Nuts—Mucuna	,,	856	
38	Mucuna—Mucuna	,,	868	+ 16
39	Ground Nuts—Mucuna	,,	848	
40	Pigeon Peas—Mucuna	,,	684	− 88
41	Ground Nuts—Mucuna	,,	696	

Average ... 837·2

Each Plot ¼ acre. Maize Test Crop sown 2nd April, harvested 1st to 4th August 1927.

Average decrease on 4 plots following Canavalia and Mucuna as compared with Ground Nuts, − 93 ± 90 lb. per acre.

Average decrease on 4 plots following Mucuna and Mucuna as compared with Ground Nuts, − 89 ± 90 lb. per acre.

Average decrease on 4 plots following Pigeon Peas and Mucuna as compared with Ground Nuts, − 170 ± 90 lb. per acre.

Root –Mean–Square difference between neighbouring Control Plots ... 180 lb. per acre.

TABLE No. 4.

Maize—Distance of Planting.

Plot No.	Treatment Spacing.	Yield per acre, lb. dry grain.	Increase or decrease compared with mean of adjacent controls.
Block D, 44-60.			
44	1′ 6″ two at a stand ...	468	
45	2′ two „ ...	300	− 130
46	1′ 6″ two „ ...	392	
47	9″ one „ ...	272	− 216
48	1′ 6″ two „ ...	584	
49	2′ two „ ...	516	− 164
50	1′ 6″ two „ ...	776	
51	9″ one „ ...	356	− 528
52	1′ 6″ two „ ...	992	
53	2′ two „ ...	636	− 138
54	1′ 6″ two „ ...	556	
55	9″ one „ ...	828	+ 136
56	1′ 6″ two „ ...	828	
57	2′ two „ ...	632	− 188
58	1′ 6″ two „ ...	812	
59	9″ one „ ...	852	+ 20
60	1′ 6″ two „ ...	852	
		Average 695·5	

Each Plot $\frac{1}{4}$ acre—Maize sown 3rd April—Harvested 27th July.

Increase or decrease of plots with two feet spacing.

− 130 lb. per acre.
− 164 lb. „
− 138 lb. „
− 188 lb. „
Average − 155 ± 111 lb. per acre.

Increase or decrease of plots with nine inches spacing.

− 216 lb. per acre.
− 528 lb. „
+ 136 lb. „
+ 20 lb. „
Average − 147 ± 111 lb. per acre.

Root-Mean-Square difference between neighbouring Control Plots, 222 lb. per acre.

TABLE No. 5.

Effect on Farm Land of Nil Oil Palms and Oil Palms in varying frequency.

Plot No.	Treatment.	Crop.	Yield, lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block H, 51–67.				
51	Nil Oil Palms	Maize	144	
53	21 „	„	196	− 4·5
55	Nil „	„	257	
57	33 „	„	169	− 53·5
59	Nil „	„	188	
61	21 „	„	217	+ 9·5
63	Nil „	„	227	
65	33 „	„	188	− 6·5
67	Nil „	„	162	

Average ... ... 195 lb. per acre.

Each Plot 1 acre—Maize sown 10th August—harvested 7th and 8th December.

Increase (+) or Decrease (−) on plots having 21 Oil Palms per acre.

− 4·5

+ 9·5

Average + 2·5 ± 54 lb. per acre.

Increase (+) or Decrease (−) on plots having 33 Oil Palms per acre.

− 53·5

− 6·5

Average − 30 ± 54 lb. per acre.

Root—Mean—Square difference between neighbouring pairs of Control Plots, 76 lb. per acre.

TABLE No 6.

Palms in Stumped and Cropped Land *versus* Palms Planted in Rides in the Original Bush.

Plot No.	Treatment.	No. of bearing trees.	No. of bunches.	Weight of bunches.	Weight of fruit.
H 31	Coppiced and Cropped	...	...	...	...
H 33	Stumped and Cropped	12	64	171 lb.	107 lb.
H 35	Coppiced and Cropped	...	...	...	...
H 37	Stumped and Cropped	10	54	192 lb.	112 lb.
H 39	Coppiced and Cropped	...	...	...	...

Palms planted, 1923.

Standard bush first coppiced, 1926.

Table No. 7.

Costs of Cultivation of Main Crops, in Man-Days per Acre.

Crop.	Preparation.	Establishing.	After cultivation.	Harvesting.	Total.
Maize	12·3	5·0	12·2	4·7	34·2
Yams	9·2	37·5	36·4	18·0	101·1
Cover Crop ...	19·8	2·6	7·0	3·2	32·6

TABLE No. 8.—RAINFALL, 1927.

Umuahia Agricultural Station.

Month.	Rainfall in inches.	Average Rainfall for four years, 1923 to 1927.
January	2·26	·51
February	·41	1·55
March	1·62	4·73
April	11·68	10·09
May	13·39	10·76
June	18·18	14·92
July	9·71	9·88
August	17·00	11·44
September	13·04	15·88
October...	12·13	10·88
November	3·10	2·19
December	1·39	·41
Totals	103·91	92·94

ANNUAL REPORT, ILORIN PLANTATION, 1927.

BY

W. B. Dowson, B.Sc.

Total area of Experimental Station 297 acres.

Area under cultivation 110 acres.

Latitude 8° 30′ North, Longitude 4° 34′ East.

Altitude, 920 feet (approx.).

Mean Annual Rainfall 1905-26, 50.43 inches.

Distance from nearest point on coast, 146 miles.

The farm is situated in open park-like country, the soil being light, sandy to gravelly, of lateritic origin and fertility generally poor. Plots are each one quarter acre with ridges six feet apart.

The following Officers were in charge for the periods shown :—

T. Thornton.—January 1st—December 28th, 1927.

W. B. Dowson.—December 29th, 1927—March 31st, 1928.

During the period under review investigations were continued on the maintenance of fertility under the three year rotational scheme evolved in 1924, the yielding capacity of three strains of Ishan cotton against the local variety when interplanted through yams and when grown as sole crop, and the testing of two varieties of groundnuts on average and poor soils, with enquiries into the possibilities of groundnuts with interplanted guinea corn.

Total rainfall for the year was normal (*see* Table No. 1) but the wettest period, which usually occurs in September, fell this year in October and was followed by high incidence of bacterial disease in cotton. Yields of both cotton varieties were abnormally low. Late commencement of the rains resulted in poor germination of yams and in groundnuts being planted too late to obtain a maximum crop. Maize was an average crop and guinea corn well above average.

Fertility Experiments.—Table No. 2.

In 1924 the following three year rotation was commenced :—

First year.—Maize and interplanted guinea corn;
Second year.—Yams and interplanted cotton;
Third year.—Mucuna (to remain whole season);

and three blocks, each of five acres, were planted in these crops. Two of these blocks this year have carried the same crops as in 1924. Results indicate that fertility is maintained in the block this year in maize and guinea corn, but some years must elapse before definite conclusions can be drawn. Poor yam germination in 1924 and high disease incidence in cotton this year mitigate against a fair comparison of the cropping of the block in yams and cotton in 1924 and 1927, but on the whole, results are encouraging.

It is probable that, for the requirements of this area, a modification of this rotation to include ground nuts will be desirable.

Cotton Experiments.

In Ilorin Province, practically all cotton is interplanted through yams, seed being sown in early July on the flank of the small hill or ridge on which the yam is grown. Two or three plants are allowed to remain at a stand. On the experimental station this year a small subsidiary ridge was made in the furrows between the yam ridges and the cotton sown on the subsidiary ridge.

In the yield tests of the Ishan strains A., B., and E. against the local variety, owing to differences in detail in methods of planting the two varieties (necessitated by shortage of seed of the Ishan strains), differences which, at planting time, were considered unimportant but later proved to have considerable effect on the final stand of plants obtained, the results must be considered as indicative only. Full tables and figures are therefore not given.

Ilorin variety gave rather higher yields than Ishan strains A. and B., but the percentage of clean seed cotton from the latter variety was markedly higher than from the Ilorin. Ishan A. and B. proved definitely heavier yielders than E. Jassids were prevalent on the Ilorin variety and Ishan E. and both these cottons were severely attacked by leaf curl. Ishan A. and B. showed considerable degree of immunity from both jassid attack and leaf curl.

It was observed in late September that cotton through yams was noticeably more free from bacterial disease than was cotton as sole crop

Ten acres of Kabba cotton were sown on June 6th, to maintain a pure strain of this variety and to afford material for selection. In October, apparently 100 *per cent.* of plants were heavily infected with leaf curl. The jassid population was very high and bacterial disease, chiefly *Black arm*, prevalent. In early November all plants were practically leafless but this stage was immediately followed by vigorous secondary growth. Yields were so low as not to be worth recording.

Groundnuts.

Two variety tests of Chinese *versus* Ilorin No. 2 were conducted, on good and average soils.

Chinese is approximately two weeks earlier in maturing than Ilorin No. 2, an important point in this area where, to obtain maximum yield, nuts should be sown in March with the first rains and harvested in August before wet conditions set in in September.

Both varieties this year showed a high percentage of shells containing withered kernels.

Guinea corn was sown on May 30th in the furrows between the groundnuts. Yields were good and the combined crop would appear to be a paying proposition.

Owing to the fact that neither the sowing nor the harvesting of the two varieties of groundnut were carried out by identical methods, it is not considered that the results are strictly comparable. They are therefore not recorded.

Yam Yield Test.—Table No. 3.

The following three species of *Dioscorea* were tested for yield and to observe their effect on interplanted cotton.

	Local Name.	
D.Rotundata.	Boki	Large tuber, yellow fleshed, late maturing.
D.Alata.	White Lisbon	Water Yam, intermediate in maturity.
D.Cayenensis?	Pansaga ...	Small, white, early maturing (8 months.)

	lb. per acre.	Odds that difference is significant.
Boki (Average yield 9 plots)	7,965	—
White Lisbon (Average difference 4 plots) ...	+1,859 ± 564	2,084 : 1
Pansaga (Average difference 4 plots) ...	−3,278 ± 564	∞ : 1

Yields of all three are very low, due principally to poverty of soil. Germination of Boki and Pansaga was very poor in comparison with White Lisbon. The latter yam in this block was only very slightly infected with a disease, not yet diagnosed, which this year, through damage to leaf and stem, ruined the crop of White Lisbon elsewhere on the farm.

In 1926 Boki gave a much heavier yield than either Pansaga or White Lisbon (*see* Table No. 8, Ilorin Report, 1927 Bulletin).

The effect of the varying rates of maturing of the yams was noticeably reflected in the vegetative growth of the interplanted cotton, and was very marked in the case of Pansaga, the earliest maturing yam.

EFFECT OF VARIOUS CROPS ON THE SOIL.—TABLE No. 4.

In 1926 the following crops were grown :—

Maize and guinea corn (control)	10 plots.
Yams	3 ,,
Maize and mucuna	3 ,,
Groundnuts and guinea corn	3 ,,

Maize and guinea corn have this year been grown to test the degree to which the soil has been exhausted by the above crops.

	Maize and G. Corn Combined Crop. Dry Grain. lb. per acre.	Odds that difference is significant.
Average yield 10 plots following Maize and G. Corn	1,156	—
Average difference 3 plots following Yams	+172±201·5	4 : 1
Average difference 3 plots following Maize and Mucuna	+174±201·5	3 : 1
Average difference 3 plots following G. Nuts and G. Corn	− 16±201·5	—

The results are inconclusive. Growth of mucuna in the maize and mucuna plots in 1926 was fair up to mid-December but it did not make any further growth. Growth of maize in May and June this year in the control plots (in maize and guinea corn in 1926) appeared to be more backward than on the other plots.

Limes.—Two acres (plots 21-28) were planted in 1915, plots 25-28 yielding much less than plots 21-24 until 1925 when the yields came more into line.

This season, yields from both blocks are very low though the yield of other citrus fruits, grape fruit, oranges and tangerines on the farm has been heavy. Many of the lime trees are now badly diseased. Yields for the past four years are given below.

	Plots 21–24 1 Acre.	Plots 25–28 1 Acre.
	Lb.	Lb.
1924	26,234	6,982
1925	34,200	23,362
1926	14,534	17,742
1927	11,914	11,073

Coconuts.—One acre was planted in 1918. Seven palms flowered this season but no fruit was set.

Orchard.—Budded oranges, tangerines and grape fruit yielded heavily. Tangerines were attacked by a bug, similar in character to bollworm. The attack resulted in seventy-five *per cent.* of the fruit being shed.

Rice.—No experiments were conducted. Small multiplication plots of varieties Guiana Creole, Guiana Seventy-five and Maliya were maintained.

W. B. DOWSON,

Superintendent.

TABLE No. 1.

Rainfall.

Experimental Station, Ilorin.

1927.	Inches.	Average for 22 years 1905–26.
January	—	0·13
February	0·79	0·81
March	—	1·86
April	5·68	4·58
May	9·44	6·60
June	8·24	7·28
July	4·41	5·85
August	2·89	4·76
September	7·24	10·42
October	9·98	6·37
November	1·92	1·40
December	0·38	0·38
Total	50·97	50·43 inches.

TABLE No. 2.

Maize and Guinea Corn.

In Three Year Rotation.

Plots.	Maize, Dry grain per acre in lb.	Guinea Corn Dry grain per acre in lb.	Combined Crop Dry grain per acre in lb.	1924.	
				Maize, Dry grain per acre in lb.	Guinea Corn Dry grain per acre in lb.
Block A.					
41	2,020	800	2,820	1,360	571
42	1,312	760	2,072	1,299	599
43	1,936	691	2,627	1,578	487
44	1,588	731	2,319	1,520	658
45	1,616	660	2,276	1,364	462
46	1,088	530	1,618	1,033	414
47	1,240	530	1,770	1,160	274
48	1,300	626	1,926	1,184	497
49	1,580	702	2,282	1,526	467
50	1,516	673	2,189	1,187	490
51	1,736	792	2,528	1,257	520
52	1,496	726	2,222	1,209	580
53	1,188	591	1,779	1,134	493
54	968	470	1,438	817	299
55	1,136	644	1,780	1,145	367
56	1,016	658	1,674	1,226	451
57	1,488	766	2,254	1,294	557
58	1,104	549	1,653	953	397
59	932	398	1,330	680	236
60	544	346	890	598	240

Plots $\frac{1}{4}$ acre, Ridges 6′ apart.

Maize.—Sown May 4th, Stands $1\frac{1}{2}$′ apart, 2 plants per stand.
Harvested August 25th–29th.
Var. Ilorin. Average yield dry grain per acre = 1,340 lb.
Bushel weight dry grain = 58 lb.
Cost of cultivation in man days per acre = 63·1.

Guinea Corn.—Sown June 3rd on flank of ridge between Maize stands.
Harvested December 28th.
Average yield dry grain per acre = 632 lb.
% Dry grain to grain on stalk = 66%.
Cost of cultivation in man days per acre = 24·8.

Combined Crop.—Average yield Maize and Guinea corn per acre in dry grain = 1,972 lb.
Cost of cultivation in man days per acre = 87·9.

TABLE No. 3.

YAM YIELD TEST.

WITH INTERPLANTED COTTON. VAR. IBADAN GROWN "ISHAN B".

Plots.	Yam.	Yields in lb. per acre	Increase (+) or decrease (−) compared with mean of adjacent controls.	Seed Cotton. lb. per acre.
Block H				
24	Boki	8,176		65
25	White Lisbon	8,600	+ 1,102	76
26	Boki	6,820		91
27	Pansaga	4,568	− 3,202	90
28	Boki	8,720		75
29	White Lisbon	11,172	+ 2,574	63
30	Boki	8,476		101
31	Pansaga	4,672	− 3,806	105
32	Boki	8,480		102
33	White Lisbon	10,156	+ 2,288	68
34	Boki	7,256		92
35	Pansaga	4,900	− 2,962	116
36	Boki	8,468		141
37	White Lisbon	9,368	+ 1,472	98
38	Boki	7,324		92
39	Pansaga	4,500	− 3,144	104
40	Boki	7,964		72

Yams.—

Increase (+) or decrease (−) of "White Lisbon" compared with "Boki."	Increase (+) or decrease (−) of "Pansaga" compared with "Boki."
+ 1,102	− 3,202
+ 2,574	− 3,806
+ 2,288	− 2,962
+ 1,472	− 3,144
Average + 1,859 ± 564·5 lb. per acre.	Average − 3,278·5 ± 564·5 lb. per acre.

Root—Mean—Square—Difference between pairs of neighbouring controls= 1,129 lb. per acre.
Average yield of control plots=7,965 lb. per acre.
Plots $\frac{1}{4}$ acre, Ridges 6′ apart, stands $2\frac{1}{2}$′ apart.
Planted December 21st—24th, 1926.
Harvested December 30th—31st, 1927.
Cost of cultivation in man days per acre=98·8.

Cotton.—Average yield 91 lb. per acre.
Sown July 7th, 1927, stands $1\frac{1}{2}$′ apart, one plant per stand.
Harvested January 7th—April 3rd 1928.
Cost of cultivation in man days per acre=26.

TABLE No. 4.

MAIZE AND GUINEACORN.

TEST CROPS IN EXHAUSTIBILITY OF CROPS EXPERIMENT. 1926.

Plots.	Preceding Crop 1926	Maize Dry grain lb. per acre.		Guineacorn Dry grain lb. per acre.		Maize and Guinea Corn Dry grain lb. per acre.		Increase (+) or Decrease (−) compared with mean of adjacent controls.
Block A								
41	Maize and Guinea Corn (Control)	824		822		1,646		
42	Yams		784		538		1,322	− 113
43	Maize and Guinea Corn ...	564		651		1,215		
44	Maize and Mucuna ...		884		665		1,549	+ 333
45	Maize and Guinea Corn ...	524		693		1,217		
46	Groundnuts and Guinea Corn		572		560		1,132	+ 42
47	Maize and Guinea Corn ...	404		560		964		
48	Yams		756		648		1,404	+ 274
49	Maize and Guinea Corn ...	556		740		1,296		
50	Maize and Mucuna ...		648		770		1,418	+ 15
51	Maize and Guinea Corn ...	696		814		1,510		
52	Groundnuts and Guinea Corn		536		670		1,206	− 44
53	Maize and Guinea Corn ...	496		494		990		
54	Yams		908		596		1,504	+ 356
55	Maize and Guinea Corn ...	668		638		1,306		
56	Maize and Mucuna ..		856		657		1,513	+ 488*
57	Maize and Guinea Corn ...	388		356		744		
58	Groundnuts and Guinea Corn		396		268		664	− 45
59	Maize and Guinea Corn ...	316		359		675		
60	Maize and Guinea Corn ...		444		502		946	Non Experimental.

Increase (+) or decrease (−) of Maize and Guinea Corn following Yams compared with Maize and Guinea Corn following Maize and Guinea Corn.	Increase (+) or decrease (−) of Maize and Guinea Corn following Maize and Mucuna compared with Maize and Guinea Corn following Maize and Guinea Corn.	Increase (+) or decrease (−) of Maize and Guinea Corn following Ground Nuts and Guinea Corn compared with Maize and Guinea Corn following Maize and G. Corn.
− 113	+ 333	+ 42
+ 274	+ 15	− 44
+ 356	+ *	− 45
Average + 172 ± 201·5 lb. per acre.	Average + 174 ± 247 lb. per acre.	Average − 16 ± 201·5 lb. per acre.

* Figure omitted owing to obvious soil variation between plots 55, 56 and 57.
Root—Mean—Square—Difference between neighbouring controls = 349 lb. per acre.
Plots ¼ Acre—Ridges 6' apart.

Maize.—Sown May 12th stands 2' apart, Harvested Sept. 12th—16th.
Bushel wt. dry grain = 58 lb. Average yield dry grain per acre = 611 lb.
Cost of cultivation in man days per acre = 38·7.

Guineacorn.—Sown June 1st, stands 2' apart on flank of ridge alternating with Maize stands.
Harvested December 13th—15th. % dry grain to grain on stalk = 69%
Average yield Dry Grain per acre = 600 lb.
Cost of cultivation in man days per acre = 30·7.

ADMINISTRATIVE REPORT ON WORK IN THE NORTHERN PROVINCES, 1927.

BY

J. R. Mackie, b.sc.

The following is a short summary of the experimental work carried out at the various experimental stations in the Northern Provinces during 1927.

Rainfall.—The rainfall at all our stations in Northern Nigeria during 1927 was rather above the average with the result that good crops were produced, and some interesting experimental results obtained.

Staff.—There was always one Superintendent of Agriculture at each station, and in some cases two. During the dry season there were sufficient Superintendents of Agriculture in the country to enable me to post one to each Emirate to take charge of the cotton markets, in addition to one at each station.

The native staff have worked well, but there is no doubt that here in the north we are handicapped by the lack of really well-trained Native Assistants of the type of the higher paid Assistants in the south. Most Mallams can read and write Ajumi but only a few can read or write English: they are not altogether unintelligent but are sadly lacking in initiative and it is doubtful if any of them have grasped in any way the meaning of our experimental work.

Samaru and Kano.

Bullock Cultivation.- Great progress with bullock cultivation was made at both stations, and the Superintendents of Agriculture, especially Mr. Owen, have displayed much ingenuity in devising suitable forms of wooden ploughs and other implements which can be made cheaply by the local people. The implements at present in use are doing satisfactory work and the greater part of the Kano Plantation was cultivated by bullock-drawn implements last season, but they are still capable of improvement and work in this direction is being continued.

Kano with its light sandy soil which can be worked all through the dry season is ideal for the employment of bullock cultivation but Samaru is a more difficult problem as the soil is much heavier and becomes so hard in the dry season that it is quite impossible to work it. However, it is hoped that bullock cultivation will replace hand cultivation over a considerable area of the farm this season.

At Kano it was shown conclusively that a farmer with a pair of bullocks could easily cultivate twice as much land as a farmer using the ordinary methods of hand cultivation. Both at Kano and Samaru it has been found that the bullocks are remarkably tractable and take to the work very kindly. So far no difficulty has been experienced in training the labourers to work them.

Manurial Experiments.—It has been proved at both stations that the system of kraaling cattle on the land during the dry season is a very wasteful method of manuring and that it is much more satisfactory to make the manure in a pen and cart it out to the fields. At Samaru it has been found that the relative value of pen manure to kraaling is approximately 2 : 1, *i.e.*, 200 cattle nights of pen manure will produce the same effect as 400 cattle nights kraaled, but apart from this, the great advantage of pen manure lies in the fact that it is made throughout the wet season when under the existing native system it is wasted, as during the rains the cattle sleep in the bush. At Kano the natives do to some extent make use of the manure made by the small stock round their compounds but it is not kept in a covered pen. The manure produced in this way is, however, very valuable and experiments are being carried out to find out how it compares with manure made in a covered pen which has been well supplied with extra organic matter in the form of bedding. Several experiments with artificial manures have been carried out at both stations, their chief object being to ascertain whether ground Nigerian Rock Phosphate either alone or in combination with other manures would be worth recommending to the natives, but the results so far show that while it does have a slight beneficial effect when applied with F.Y.M., otherwise its value is almost negligible. These experiments have also shown that quick acting nitrogenous manures such as sulphate of ammonia are by no means as effective as F.Y.M. Our experiments have shown that early green manure is not a practicable proposition in Zaria and Kano, owing to the shortness of the growing period, but there is a good deal of evidence to show that green manure left on the land for a whole season has a very beneficial effect, and our farms at Bomo and Maigana are now being farmed on a system of two years cotton and one year green manure. This system appears to maintain the land in a fair state of fertility.

I am inclined to think that it would be worth while to try to induce a few farmers to give green manuring a trial, for although it is now almost certain that our ultimate object in extension work will be to introduce a system of mixed farming, this will be a slow process and it might be well to make a start with green manuring, especially as the growing of mucuna for fodder is

likely to be an essential feature of any system of mixed farming. There is still a good deal to be learned with regard to the best method of interplanting legumes with other crops and our efforts in this direction have not been completely successful.

Exhaustibility of Crops.—A good deal of information has been obtained as to the effect of the various crops on the soil. In this connection there is a curious difference between the results obtained at Kano and Samaru with regard to groundnuts which is rather difficult to explain, for at Kano they appear to take more out of the soil than any other crop while at Zaria they appear to be even less exhausting than cotton.

Fodder Crops.—Experiments are being conducted to test the best means of growing and dealing with fodder crops. Mucuna is at present without a rival as a fodder crop, as not only does it give very heavy yield, but it produces hay which is palatable to the cattle. Efforts are now being made to find a wild leguminous plant which might prove to be of value as a forage crop, but it is doubtful if this investigation will produce results of any value. Hay made from the local grasses has given good results when mixed with mucuna hay.

Our experiments with the subsequent treatment of fodder crops quite justify our present system of making them into hay and feeding to the cattle in pens during the dry season, and hay making with both grass and fodder crops is now a definite item of work at the end of the rains.

Stock Breeding.—Pending the opening of the new stock farm at Shika a start on the improvement of cattle has been made at Samaru. A small herd of the Shuwa type of cattle was purchased in Bornu last July, trekked down to Vom for inoculation against rinderpest, and then trekked to Samaru. On arrival, they were very exhausted and in very poor condition. During the first few months several deaths occurred, especially among the calves, but they have improved steadily throughout the dry season. There have been no further losses during the last two months and as a result of careful feeding with a small supply of concentrates and plenty of fodder they are now in very good condition. We are steadily accumulating data as to milk yields, service period, dentition, etc., which will be of great value in the future.

Buildings.—Great progress has been made at Samaru with the erection of buildings and there is now a complete farm-yard with cattle pens, store, hay barn, milking shed and dairy. These have all been made of laterite and have been provided with a corrugated iron roof.

Sokoto.

Progress at our irrigation farm has been somewhat disappointing as the bursting of the Marabawa Bank and subsequent flooding of the farm caused many of the experiments to be completely spoilt.

Time of planting experiments with both exotic and local varieties indicated that the period between the 17th and 24th of May was the best time of planting and the yield fell off rapidly when seed was planted later than this.

The ordinary native farmer who has to wait for the rains is unable to plant until the first week in June, so that these results tend to demonstrate the advantage to him of being able to make use of irrigation water.

Experiments with irrigated crops during the dry season have so far not being very successful, but this year's wheat crop is quite promising.

The native farmers have so far only taken up a small portion of the land available for irrigation, but those farms which have been taken up look very flourishing and the farmers appear to take full advantage of the water for growing crops in the dry season. A definite scheme, with a small water rate in lieu of rent, will probably be required in the future if full use is to be made of the land affected by the canal

Benue.

This station was started in rather difficult circumstances owing to the famine which has prevailed in that area for the last two seasons, and progress was a little slow at first, but a real advance has been made this season and some very useful results were obtained from the experiments carried out.

Climatically the conditions in the Benue Province are very similar to those of Ilorin and it is not surprising to find therefore that the results obtained from the experimental work confirm the results obtained there.

Important results were obtained with both beniseed and groundnuts and experiments were carried out with yams to try to find a method of dealing with the damage caused by the yam beetle which is a very serious pest in this area. These experiments are being continued and it is hoped that by the end of the present season we shall be in a position to make definite recommendations to the native on this subject.

Benniseed is extensively grown in this area as a money crop; and several experiments were carried out to test the best method of growing and harvesting it. By means of improved methods of cultivation we were able to obtain a yield greatly in excess of that obtained by the local natives at very little extra cost.

Groundnuts are hardly grown at all by the Munshis, and it was suspected that either the soil or the climate was unsuitable, but our experiments show that, as at Ilorin, groundnuts can be successfully grown provided they are planted sufficiently early. This result is most encouraging and opens up great possibilities of making the Munshi area a new groundnut-producing region. It was found that although groundnuts are more expensive to grow than beniseed they are far more profitable to the grower even at the ridiculously low price of £4 per ton. Tests of Allen cotton, Ishan A. and the local variety were carried out, but the season was a bad one and the results were disappointing. It seems likely that an improved strain of the local variety will be the most suitable cotton for this area and attempts are being made to find a suitable strain. Mr. James, the Superintendent of Agriculture in charge is to be congratulated on having made so much progress, especially as he has trained the whole of his staff himself from material supplied from the Provincial Schools.

Extension Work.

As a result of the visit of Dr. Engledow, a new scheme for organised seed distribution has been drawn up the object of which is to maintain the quality of the American cotton produced in the Northern Provinces by supplying the farmers with fresh seed from selected strains every three or four years. This scheme is to come into operation this season, and the work of multiplying the selected strain will devolve on the Empire Cotton Growing Corporation's Seed Farm at Daudawa.

Previous to this the entire work of selection, multiplication and distribution had been carried out by this Department, the quantity distributed last season being 2,321 tons.

The system of grading and inspection by means of organised cotton markets at gazetted stations continued to run smoothly. Unfortunately the crop was disappointing and only amounted to 15,515 bales, but the quality of the cotton was higher than usual.

The most encouraging feature of the last cotton season was the increased in production in the Sokoto Province, which judging by the quantity of seed already taken this season is likely to be continued.

Several new markets were opened in the Benue Province but it will probably be some years before their existence will be justified by the quantity of cotton purchased.

J. R. MACKIE,

for Asst. Director of Agriculture,
Northern Provinces.

Zaria,

9th June, 1928.

ANNUAL REPORT, SAMARU AGRICULTURAL STATION, 1927.

BY

B. G. Owen, B.A.

In one respect in particular the results of season 1927-28 can be said to have been most successful. They have led to the conclusion that a system of mixed farming in the district is not merely practicable, but economically and agriculturally sound.

Many new problems necessarily arise in attempting to introduce a system of this sort, such as the provision of implements, the feeding of the cattle during the dry season and the housing of the stock, but we have been able to show that none of these are insurmountable.

We have already been able to make satisfactory wooden ploughs and other implements from local materials, and they are in constant use on our own farm, a large portion of which is now cultivated by means of bullock-drawn implements, and it is anticipated that the manure produced by the stock if properly made, will be sufficient to maintain the increased acreage, which it will be possible for a farmer to cultivate, in a high state of fertility.

Some of the results already obtained may be summarised as follows:—

(*a*) The local cattle can be trained with little trouble to draw cultivation implements.

(*b*) The manure carted from a roofed pen into which the cattle are driven at night produces greater crop yields than manure made by cattle tethered on the farm at night, quantity for quantity, and there is no reason why manure should not be made in pens at night throughout the year, instead of being wasted during the wet season, when normally Fulani cattle are grazing and sleeping in the bush. An obvious reason why the pen manure should be superior is that it is protected from the sun and rain until almost the date of planting whereas the manure produced by "kraaling" is exposed to the weather for several months. "Kraaling" is the system almost universally adopted at present, as during the period December—March, *i.e.*, from one to four months before sowing, the native usually grazes his cattle over the land by day, allowing them to feed on any food such as Guinea corn trash, etc., which may be available, and then tethers them there at night.

(*c*) Mucuna (Stizolobium vars.) can be grown at low cost when interplanted with a cereal crop and makes excellent hay for feeding to cattle during the dry season when there is practically no food in the bush.

(*d*) The great response made by the soil to manures containing nitrogen, and therefore the great value of animal manure.

These results are distinctly encouraging, and indicate that no serious difficulty should be encountered in attempting to induce the Hausa farmer to adopt a system of mixed farming. The normal present state of affairs is for the Hausa farmer to own no cattle and for the Fulani cattle owner to have no farm.

Rainfall and Weather.

The rainfall, on which so much depends, differed considerably in distribution from that of any previous year during which the Department has conducted experiments at Samaru. Although the total fall was not much more than the average of the preceding three years—49.90″ against 46.08″—yet the distribution was unique in the records of the station, in that July was abnormally dry and September abnormally wet. For details *see* Table No. 1.

Since the end of the rains the most noticeable feature has been that the harmattan was later and less severe than usual; in fact most of the cotton, which is the last crop removed from the farm, had been picked before any severe harmattan occurred.

Cotton.

Grew very well for the first six weeks after planting, but then suffered a great deal from water logging especially during September, the period of abnormal rainfall (*see* Table No. 1).

The seed cotton was graded after picking as in former years, perhaps rather too strictly, as the weight of Grade 2 seed cotton was 10.80 *per cent.* of the total weight of seed cotton and the weight of Grade 2 lint was 10.99 *per cent.* of the total weight of lint. The average ginning percentage of Grade 1 main crop (Allen M1) was 29.74 *per cent.* The lint was bright, strong, and of good average length and elicited favourable comments at the Ginnery (Zaria).

Imported Beans.

Where interplanted they failed badly, but new ideas have arisen as a consequence and different schemes of interplanting are to be adopted in 1928.

The small white lima bean—CN/9 (Phaseolus vulgaris lunatus)—yielded at the rate of 151 lb. per acre unthreshed where planted alone. This bean has been very favourably reported on by he

Imperial Institute and various merchants in England and efforts are now being made to produce it on a commercial scale. The "Lubia" bean from Egypt failed owing to insect attack. Mucuna was an excellent crop, both alone and when planted among gero and subsequently ridged up. The superiority of Nyasaland varieties (*see* Table No. 5) over the black seeded variety is of great interest, as it means a large extra yield of fodder per acre.

Early Green Manure Experiment.

(*See* Table No. 2.)

Conducted on the same plots as in the two previous years. The early green manure (mucuna) made very slight growth and does not seem to have caused any increased yield of cotton. Indeed it would be remarkable if the turning in of such a very small growth did have any effect.

	Pounds seed cotton per acre.	Odds that difference is significant.
Average yield of 7 plots, without Early Green manure	231	—
Average difference of 6 plots with Early Green manure as compared with those without Early Green Manure	+ 2·7 ± 31	—

Exhaustibility of Crops Experiments.

(*See* Table Nos. 3 and 4.)

The 1925 exhaustion crops were again grown on the same plots, Block A. 14-26 was converted this season to six feet ridges. Block A. 27-39 remaining on four feet ridges as before.

(*a*) *A 14-26.*—Here the average yield of groundnuts has declined. Cotton is poor partly owing to water logging and maize shows a large increase, probably due to the preliminary ridging necessitated by the conversion, a treatment which maize does not ordinarily receive.

(*b*) *A 27-39.*—General fall, in yields, particularly guinea corn. An irregular field, also affected by water-logging.

Mucuna Variety Test.

(*See* Table No. 5.)

Here some promising results were obtained, the four Nyasaland varieties, whose reference numbers and names are given below, (Table 5), all yielded better than the local " black seeded " variety. Further test will be made in 1928.

	Pounds of hay (one day-dried) per acre.	Odds that difference is significant.
Average yield of 17 plots of "Black Seeded" variety	1,913	—
Average difference of 4 plots of CN/54 variety as compared with "Black Seeded"	+ 44 ± 340	—
Average difference of 4 plots of CN/16 variety as compared with "Black Seeded"	+ 531 ± 340	15 : 1
Average difference of 4 plots of CN/73 variety as compared with "Black Seeded"	+ 456 ± 340	10 : 1
Average difference of 4 plots of CN/59 variety as compared with "Black Seeded"	+ 587 ± 340	22 : 1

Phosphate Test—Superphosphate *v.* Nigerian Rock Phosphate (*See* Table No. 6.)

Working on the basis that the superphosphate which we had in stock contained 30 *per cent.* water soluble phosphate (as P_2O_5) and that Nigerian Rock Phosphate contains 33 *per cent.* of total phosphate as P_2O_5), standard plots received 200 lb. per acre of Nigerian Rock Phosphate = 66 lb. phosphate per acre, Treatment plots received 220 lb. per acre of superphosphate = 66 lb. water-soluble phosphate per acre.

Thus the experiment was designed to test the availability of phosphate as supplied in superphosphate as against that supplied in Nigerian Rock Phosphate, quantity for quantity.

Mucuna was grown, harvested and weighed as "one-day-dried" hay. As expected, the yields of the plots receiving superphosphate were much the higher. The phosphate contained in Nigerian Rock Phosphate does not therefore seem to be very readily available.

	Lb. per acre "one-day-dried"	Odds that difference is significant.
Average yield per acre of 10 plots receiving 200 lb. Nigerian Rock Phosphate per acre	2,328·0	—
Average difference of 9 plots receiving 220 lb. Superphosphate per acre ...	+ 1,229·8 ± 128·7	∝ : 1

Manurial Experiment.

(*See* Table No. 7.)

This was carried out on thirty-four plots, each of $\frac{1}{8}$ acre, and against a standard dressing of three tons of pen manure per acre, the following were tested :—

(*a*) 200 lb. Nigerian Rock Phosphate per acre.

(*b*) 200 lb. Nigerian Rock Phosphate + 75 lb. sulphate of ammonia per acre.

(*c*) Three tons pen manure + 200 lb. Nigerian Rock Phosphate per acre.

(*d*) No manure.

(*e*) 200 lb. Nigerian Rock Phosphate + 60 lb. muriate of potash per acre.

Nigerian Rock Phosphate did moderately well here. While it was, at the rates applied, markedly inferior to pen manure, yet it produced a much larger average yield than the unmanured plots and increased the yield when combined with pen manure. The higher average yield where sulphate of ammonia is added to Nigerian Rock Phosphate shows the lack of nitrogen in the soil. It seems unnecessary to supply potash salt. Thus, the results show that the soil responds greatly to nitrogen, to a less extent to phosphate and hardly at all to potash.

	Lb. per acre guinea-corn on head.	Odds that difference is significant.
Average yield of 17 plots receiving 3 ton pen manure per acre	1,553	--
Average difference of 4 plots receiving 200 lb. Nigerian Rock Phosphate per acre ...	− 363 ± 89·6	33,000 : 1
Average difference of 3 plots receiving 200 lb. Nigerian Rock Phosphate and 75 lb. Sulphate of Ammonia per acre. ...	− 135 ± 103·7	9 : 1
Average difference of 3 plots receiving 3 tons pen manure and 200 lb. Nigerian Rock Phosphate per acre	− 210 ± 103·7	43 : 1
Average difference of 3 plots receiving no manure	− 776 ± 103·7	∞ : 1
Average difference of 3 plots receiving 200 lb. Nigerian Rock Phosphate and 60 lb. Muriate of Potash per acre ...	+ 450 ± 103·7	∞ : 1

Gero and Mucuna for Fodder.

(*See* Table No. 8.)

Gero was sown at two foot spacings on all ridges, but neighbouring plants were on alternate sides of the ridge. Mucuna was later interplanted. In due course the gero was cut at ground level on standard plots, and two feet above ground on treatment plots to see whether the mucuna, would climb up the gero stalks and produce an extra weight of hay.

The mucuna was not subsequently ridged up, but merely hoed. (Compare Field C 34-66, Table No. 10). It grew poorly on account of early shade and later heavy rain and did not climb the gero to any extent. Consequently the result was insignificant.

	Pounds of "one day-dried" mucuna hay per acre.	Odds that difference is significant.
Average yield of 16 standard plots ...	410	—
Average difference of 15 treatment plots...	+24·4 ± 45·6	—

Interplanting Test. Lima *v.* Wake in Guineacorn.

Here the interplants all died owing to water-logging and intense shade. While the failure is deplorable it has given rise to some new ideas on interplanting which will be tested in 1928.

Fodder Crop Experiment (Block C 1-33).

(*See* Tables Nos. 9 and 9a.)

On this block, in 1926-27, eight rows of gero were grown on all plots and, in addition guinea corn and wake on the standard (odd numbered) plots, and mucuna, treated in various ways, on the treatment (even numbered) plots.

The wake on the standard plots failed and its effect may therefore be neglected. Thus, we may regard the comparative 1926-27 exhaustion as :—

On standard plots—that caused by the gero and guinea corn.

On treatment plots—that caused by the gero and mucuna.

The sixteen treatment plots were divided into four groups of four plots each, each group treated differently, thus :—

Group 1.—Mucuna removed entirely and farm yard manure equivalent returned.

Group 2.—Mucuna removed entirely.

Group 3.—Mucuna turned in for green manure.

Group 4.—Mucuna folded on plots (in November).

In 1927-28, Guinea corn only was grown on all plots.

	Lb. per acre. "on head."	Odds that difference is significant.
Average of 17 plots of guinea corn, after gero and guinea corn	686·8	—
Average difference of 4 plots of guinea-corn, after gero with mucuna removed, and farm yard manure equivalent returned	+365±97·7	15,000 : 1
Average difference of 4 plots of guinea-corn, after gero with mucuna removed entirely	+205±97·7	50 : 1
Average difference of 4 plots of guinea-corn, after gero with mucuna turned in for green manure	+521±97·7	∝ : 1
Average difference of 4 plots of guinea-corn, after gero with mucuna folded (in November)	+174±97·7	15 : 1

It will be seen that after the removal of mucuna and the return of its farm yard manure equivalent, or after turning in mucuna for green manure far better yields of guinea corn occur in the following year than after guinea corn and gero.

Where mucuna is removed entirely a better yield also results, understandably a smaller one, but the relatively low increase produced by folding is surprising.

Considering the case from a more detailed and practical aspect, the following question arises—"Can a farmer, by growing gero with mucuna instead of with guinea corn in the first year (*i.e.*, 1926) expect, by treating the mucuna in one or other of the ways in which we have treated ours, to get an extra yield of guinea corn in the succeeding one, two, or three years, which will repay to him the quantity he might have obtained in the first year by sowing guinea corn with his gero instead of mucuna?" Applying this question, the first important point which arises is the fact that he undoubtedly gets a larger crop of gero when he sows mucuna with it than when he interplants guinea corn, as the figures before show :—

	Lb. per acre.	Odds that difference is significant.
Average yield of 17 plots of gero with dawa (1926)	473·2	—
Average difference of 16 plots gero without dawa but with mucuna (1926) ...	+117·8±54·8	50 : 1

It is therefore better to treat the matter in the terms of "corn" rather than "guinea corn", and if gero and guinea corn are each considered to have the same unit value (this procedure is of course somewhat questionable) then the following figures may be worked out.

Quantities of Corn still to be Recovered after the Second Year (1927) to compensate for Non-sowing of Guinea corn in the First Year (1926).

(*See* Table No. 9A.)

After removing mucuna and returning Farm yard manure equivalent.	After removing a crop of mucuna entirely.
Average of 4 plots, 542 lb. per acre.	Average of 4 plots, 634 lb. per acre.
After turning in a crop of mucuna for green manure.	**After folding a crop of mucuna.**
Average of 4 plots, 120 lb. per acre.	Average of 4 plots, 475 lb. per acre.

To obtain the above figures the assumption has been made that if guinea corn had been sown on the treatment plots in 1926 instead of mucuna, each plot would have given a yield equal to that of the mean of the two adjacent plots. This, of course, would rarely be the case in practice, but the method seems the best one for obtaining figures on the question. Bearing in mind then the fact that these figures are liable to considerable error, the only deduction which can be drawn with much reliability is that green manuring leads to a rapid recovery of the grain which might have been obtained in the first year. The results shown earlier in the notes in this experiment corroborate this view and emphasise the value of green manuring with mucuna. Further work is to continue on this experiment.

Gero and Mucuna for Fodder.

(*See* Table No. 10.)

Details of planting and harvesting were exactly as on Block B. 36-66 (*see* Table No. 8), except that in this case the mucuna was ridged up after the removal of the gero, and grew much better as a result. Compare average yields of respective control plots, 855 lb. per acre against 410 lb. per acre. It is doubtful whether any other factor contributed to the increase except the ridging, as there is little difference in the two fields.

Regarding the cutting of gero two feet high as compared with cutting at ground level, this experiment demonstrated the value of high cutting, as the mucuna climbed the gero stalks to a very considerable extent, and, thus obtained more light, and produced more heavily.

	Pounds of "one-day-dried" mucuna hay per acre.	Odds that difference is significant.
Average yield of 17 control plots ...	855	—
Average difference of 16 Treatment plots	$+107{\cdot}3 \pm 56{\cdot}7$	34 : 1

Stale Ridge Experiment.

(*See* Table No. 11.)

Cotton sown on unridged plots was compared with cotton sown on plots ridged in the normal way. The crop grown on this field in the previous year was ground nuts, and thus the cotton sown on unridged plots was practically sown on the flat.

As expected, it gave a much less yield than that grown on ridged land, even though the field as a whole gave a very low yield. It seems evident that cultivation in plenty is a paying proposition here both in the matter of increased yield and financially, and by far the most paying cultivation before sowing cotton is ridging.

On the treatment (unridged) plots it was found necessary to hoe, partly to give the cotton a chance to grow at all and partly to eradicate self-sown ground nuts.

Costs were :—

Ridging standard plots 13.8 Man-days per acre.

Hoeing treatment plots 13.39 Man-days per acre.

The profit gained by ridging which actually cost less, was 41.4 lb. per acre, or at 2⅛d. per lb., 7s. 4d. per acre.

	Pounds of seed cotton per acre.	Odds that difference is significant.
Average of 17 standard plots	165·2	—
Average decrease of 16 treatment plots	−41·4±9·87	33,000 : 1

Ground nut Variety Test.

(*See* Table No. 12.)

Chinese and American varieties were tested against " Zaria " on Block D. 34-66. The crop was not very good.

	Lb. per acre. unshelled.	Odds that difference is significant.
Average yield of 17 plots Zaria variety	864	—
Average difference of 8 plots Chinese variety	−30·5±57·3	Nil
Average difference of 8 plots American variety	−111±57·3	34 : 1

Farm Yard Manure *v.* Kraaling Experiment.

(*See* Table No. 13.)

This was the second year of the experiment. No manure was applied in 1927, but a crop of guinea corn grown on all plots.

Yields again show the superiority of farm yard manure over an equal quantity of " kraaled " manure.

1926 and 1927 data are given both here and in the tables.

	1926, Cotton lb. per acre.	Odds that difference is significant.	1927, guinea-corn lb. per acre.	Odds that difference is significant.
Average yield of 17 plots manure with 400 cattle nights kraaling per acre	264	—	1,190	—
Average difference of 4 plots manured with 100 cattle nights Farm yard manure per acre	− 7·5±27	—	−197±90·2	100 : 1
Average difference of 4 plots manured with 200 cattle nights Farm yard manure per acre	+13·5±27	—	− 64±90·2	4 : 1
Average difference of 4 plots manured with 300 cattle nights Farm yard manure per acre	+ 35±27	14 : 1	+ 50±90·2	—
Average difference of 4 plots manured with 400 cattle nights Farm yard manure per acre	+ 80±27	740 : 1	+245±90·2	500 : 1

Thus in two years, the following money gross losses or profits are due to the various treatments, as compared with the standard.

100 Cattle Nights.	− 7·5 lb. Cotton at (say 2¼d.) ...	1s.	5d.	
	−197 „ guinea corn at (say ⅗d.) ...	9s.	10d.	
	Gross loss ...	11s.	3d.	per acre.
200 Cattle Nights.	+13·5 lb. cotton at 2¼d.	2s.	6½d.	
	−64 „ guinea corn at ⅗d.	3s.	2½d.	
	Gross loss ...		8d.	per acre.
300 Cattle Nights.	+ 35 lb. cotton at 2¼d.	6s.	7d.	
	+ 50 „ guinea corn at ⅗d.	2s.	6d.	
	Gross profit ...	9s.	1d.	per acre.
400 Cattle Nights.	+ 80 lb. cotton at 2¼d.	15s.	0d.	
	+245 „ guinea corn at ⅗d.	12s.	3d.	
	Gross profit	£1	7s.	3d. per acre.

The cost of production and estimated market values of the two crops together, expressed in terms of man-days, are :—

	Cost of production of both crops.	Market value of both crops.	Excess, *i.e.* profit.	Profit as a *per cent.* of cost.
Standard	118·2	145·3	27·1	22·9
100 CN F. Y. M. ...	116·3	130·3	14·0	12·0
200 „ „ ...	118·4	144·4	26·0	22·0
300 „ „ ...	120·5	157·4	36·9	30·6
400 „ „ ...	122·6	181·6	59·0	48·1

It seems then, considering the yields, the cash returns and the profit per unit of labour, that 200 cattle nights of F.Y.M. are approximately the equivalent of 400 cattle nights of kraaling. Further investigation is to be made.

Cotton Cultivation—Experiment (A).

(*See* Table No. 14)

This was carried out on Bomo A 1.17, the following being the cultivations :—

Standard.—Three hoeings between planting and 15th September, no ridging up, but mulching after last rains.

Treatment P.—As standards until 1st August. Then no work until 1st September when ridging up. No mulching.

	Yield of seed cotton lb. per acre.	Odds that difference is significant.
Average yield of 9 plots standard plots ...	178·1	—
Average difference of 8 "treatment P" plots	−43·4±16·9	160 : 1

It is therefore obvious that the crop responds to more cultivation by giving a better yield.

Considering the financial side of the experiment, the following figures are of interest.

	Cost of production in man-days per acre.	Market value of crop as man-days per acre at 9d.	Loss.	Loss as percentage of cost.
Standard	63·4	44·6	18·8	29·6
Treatment P	36·7	33·7	3 0	8·2

"Cost of labour" = 9d. per man-day.

No doubt this explains to some extent the small amount of cultivation given by the Hausa farmer to his cotton. While the costs of cultivation on an experimental farm are undoubtedly high and the farmer, using "Treatment P", would probably obtain a small profit, yet our relative costs must be fairly accurate. It seems rather discouraging to think that better cultivation and a larger crop mean a smaller profit, but three factors put a better appearance on the situation, namely :—

(1) Costs of production as given above are only actual "manual labour" costs. If overhead charges, *i.e.*, tax, tools, transport, etc., are included the relative "losses" as a percentage of cost will be nearer to one another.

(2) The keen native farmer will not regard the use of his "spare time" by cultivating cotton in the light of extra cost of growing it but rather as the profitable employment of time which might otherwise be wasted.

(3) After the "standard" cultivation the land is left in a much cleaner condition for the next crop.

Cotton Cultivation Experiment (B).

(*See* Table No. 15.)

On Bomo A. 18-33 two treatment cultivations ("Q" and "R") were tried against the same standard as in the last experiment. These were:—

"Treatment Q".—As standard until 15th September, after which no further treatment.

"Treatment R".—As standard until 15th September than only weeded at end of rains.

	Yield per acre lb. of seed cotton.	Odds that difference is significant.
Average yield of 8 standard plots ...	174·5	—
Average difference of 4 plots receiving Treatment Q	+3·5±25·05	Nil.
Average difference of 3 plots receiving Treatment R	+2·0±28·93	Nil.

A comparison of costs and returns (as was done in the last experiment) gives:—

	Cost of production in man-days per acre.	Market value of crop as man-days per acre @ 9d.	Loss.	Loss as a percentage of cost.
Standard	59·4	43·6	15·8	26·6
"Treatment Q" ...	46·7	44·6	2·1	4·5
"Treatment R" ...	56·3	44·1	12·2	21·7

Cost of labour = 9d. per man—day.

It might be well to try cultivation experiments again on land in a good state of fertility (Block Bomo A. is in poor "heart") as the results would then possibly be more encouraging.

Cotton Strain Test.

(*See* Table No. 16.)

On Bomo E. 1-33 Botanist's Strains D. and E. were tried against M1 as standard with the following results:—

	Seed Cotton lb. per acre.	Odds that the difference is significant.
Average yield of 17 plots M 1	249	—
Average difference of 8 plots of Botanist's Strain D	− 8 ± 25·95	—
Average difference of 8 plots of Botanist's Strain E	− 17·1 ± 25·95	—

The ginning percentage of the three strains is now to hand as follows—

M 1	... 28·43%
D	... 30·25%
E	... 26·67%

Cotton Disinfection Experiment (Bomo C).

(*See* Table No. 17.)

Nine plots of one-eighth of an acre were laid out for cotton, each 330 feet long and sixteen and a half feet wide. They were separated from one another by quarter acre plots of guinea corn, each 330 feet by thirty-three feet, and belts of guinea corn thirty-three feet wide and 478½ feet long were sown along the two sides.

The seed for the cotton plots was thoroughly mixed (at Ibadan), and divided into two heaps, of which one was disinfected by the use of strong sulphuric acid (a few minutes immersion) and the other remained untreated. The odd numbered (standard) cotton plots were sown with the untreated seed, the even numbered (treatment) plots with the disinfected seed, the object of the experiment being to determine whether—

(1) The treated seed was more free from disease, especially internal boll disease.

(2) The treated seed gave better yields.

Yield figures were :—

	Yield of seed cotton lb. per acre.	Odds that difference is significant.
Average of 5 standard plots	286	—
Average difference of 4 treatment plots ...	− 33·2 ± 22·6	12 : 1

The treated seed germinated much the more rapidly and looked a healthier stand, but by September the plants from untreated seed were equally good.

In the matter of disease, the plants from treated seed were free from angular spot, but no boll disease was seen either on treatment or standard.

Cotton Disinfection Experiment (Poultry Pen Plot).

(*See* Table No. 18.)

An exactly similar experiment to that on Bomo C. (*vide* Table No. 17).

	Yield of seed cotton lb. per acre.	Odds that the difference is significant.
Average of 5 standard plots	102·4	—
Average difference of 4 treatment plots ...	+ 21·5 ± 12·85	19 : 1

Thus the result is practically the reverse of that shown in the previous paragraph, and I am inclined to think that the disinfection does result in a larger yield, though not a very great one.

The same remarks as to germination and disease apply.

Farm Buildings.

A cattle shed 105 feet long was completed and opposite to this a " milking shed " of the same length. The " milking shed " is divided into three sections, a dairy, actual milking shed, and a store These buildings are built of local laterite stone and mud, pointed with cement and are roofed with galvanised iron. The floors are all of cement on the laterite except for that of the store, which is yet to be finished.

A permanent poultry pen adjoins.

Cattle.

The stock at the station now number sixty-nine and comprise—

8 Bulls.
2 Bullocks.
30 Cows.
14 Bull-calves.
15 Heifer calves.

Of the eight bulls, four are actual stock bulls used for service and work, the remaining four and two bullocks being used for work only. Thus there are five teams of cattle available in the absence of sickness.

Since the majority of the herd were brought from Bornu (mid-July), the number of deaths has steadily decreased.

The heavy deaths which occurred until September seem to have been due to exhaustion and digestive troubles following prolonged trekking, inoculation against rinderpest and change of environment. Blood-smears were sent to the Veterinary Pathologist at Vom, who found no traces of trypanosomiasis or other disease. Post-mortem examinations gave indefinite results.

Eleven calves have been born during the year (April 1927-March, 1928) of which two died almost at once.

The grown male animals have been trained to work with carts and implements of cultivation. They prove to be docile and are easily driven and controlled.

Since the 1st of September, 1927, daily milk records have been kept. No cow has yielded very highly but with the advent of the rains and the new grass more milk should be forthcoming. The lactation periods of the only two cows which have gone dry to date (Nos. 23 and 9) have been of six and five and a half months duration with 1,325¼ and 946½ lb. of milk respectively. These low yields show the immense room for improvement in milk cattle.

The Bornu cattle were in a very poor condition when they arrived at Samaru and they have been fed on concentrates in addition to a mixture of mucuna hay and grass. Guinea corn, ground nuts and boiled cotton seed have been the chief concentrates used and a ration of :—

3¼ lb. cotton seed (weighed dry before boiling).
1 lb. Guinea corn (threshed).
1 lb. ground nuts (decorticated) per adult beast per day has given good results.

In view of the large quantity of water which would be required for the stock a small dam was built in the stream south-west of the stock buildings. The flow of the stream continued until mid-February and no shortage of water was experienced.

Wells.

One well was dug near the cattle shed and lined with culverting. Although it penetrates six feet into rock it has not supplied the quantity of water desired, yet it has never been dry at any time. Two other wells have been sunk near the T6 and T7 houses in connection with experimental well digging, of which one has been lined with culverting. Lining with concrete rings is at present held up pending arrival of material.

Poultry.

The light Sussex and Indian game birds were all sold during the year and Rhode Island Red birds are kept. They are now housed in the new pen at the farm.

Records for the birds for the year is :—

Stock on 1/4/27	65	
Bred during year	36	101
Sold during year	76	
Died during year	13	89
Stock on 1/4/28		12

B. G. OWEN,
Superintendent of Agriculture.

TABLE No. I.

Rainfall—Samaru, 1927.

Month.	Inches of rain.	Number of days on which rain fell.	Average rainfall at Samaru, 1924–26 inclusive.
January	...	...	...
February	...	...	...
March	...	...	0·80″
April	2·84″	6	0·98″
May	5·44″	12	3·09″
June	7·05″	13	7·50″
July	3·92″*	13	12·39″
August	14·37″	22	11·47″
September	14·13″*	20	7·39′
October	2·15″	8	2·33
November	...	...	0·13″
December	...	...	...
Totals	49·90″	94	46·08″

* Exceptional.

TABLE No. 2.

Early Green Manure Experiment—

Mucuna and Cotton.

Plot.	Treatment.	Pounds per acre of seed cotton.	Increase(+) or decrease(−) compared with mean of adjacent control plots.
A 1	No Early Green Manure	168	
„ 2	With E. G. M.	205	− 4
„ 3	No Early Green Manure	250	
„ 4	With E. G. M.	315	+ 66
„ 5	No Early Green Manure	248	
„ 6	With E. G. M.	240	− 27
„ 7	No Early Green Manure	286	
„ 8	With E. G. M.	237	− 70
„ 9	No Early Green Manure	328	
„ 10	With E. G. M.	235	− 14
„ 11	No Early Green Manure	171	
„ 12	With E. G. M.	235	+ 65
„ 13	No Early Green Manure	169	

Varieties Sown :—Mucuna — "Zaria"
Cotton — "Allen No. 1."

Each plot ¼ acre. Ridges 4' apart. Single stands 15" apart.

Mucuna sown on 11th, 13th and 14th April and 25th May Turned in on 27th June.

Cotton sown on 29th June. Picked on 6th, 21st and 23rd December.

Increase (+) or decrease (−) of yields of cotton from plots receiving Early Green Manure as against those not receiving E. G. M.

− 4
+ 66
− 27
− 70
− 14
+ 65

Average + 2·7 ∓ 31 lb. per acre.

Root-mean-square-difference between neighbouring control plots = 75·9 lb. per acre.

Cost of cultivation in man-days per acre. Cotton 49·3 „
Mucuna 31·9 „

TABLE No 3.

Exhaustibility of Crops Experiment.

Plot.	Exhausting Crop Sown 1925 and 1927.	Yield per acre lb., 1925.		Yield per acre, testing crop, 1926, cotton, lb.	Increase (+) or decrease (−) in yields of cotton on treatment plots as compared with yield on standard plots, lb, per acre.	Exhausting Crop Yields, 1927 lb, per acre.	
		Standards.	Treatments.			Standards.	Treatments.
A 14	Groundnuts ...	368		348		164·5	
.. 15	Maize ...		171	376	− 16		446·5
.. 16	Groundnuts ...	288		436		183	
„ 17	Guinea corn ...		543	452	+ 12		385
„ 18	Groundnuts ...	384		444		185	
„ 19	Cotton ...		364	364	− 22		190
„ 20	Groundnuts ...	340		328		178	
„ 21	Maize ..		171	260	− 34		383·5
„ 22	Groundnuts ...	248		260		188	
„ 23	Guinea corn ...		195	192	+ 18		207
„ 24	Groundnuts ...	136		88		160	
„ 25	Cotton ...		156	104	− 8		86
„ 26	Groundnuts ...	240		136		177	

Varieties Sown :—1925 and 1927 Groundnuts — "Zaria"
Maize — Local
Guinea corn — "Kauru"
Cotton — Allen M. 1.
1926 Cotton — Allen M. 1.

Each plot ¼ acre. Ridges 4′ apart in 1925 and 1926, 6′ apart in 1927.

1926 Data :—

Increase (+) or decrease (−) of yields of cotton on plots previously sown with maize as compared with yield on those previously sown with Groundnut.	Increase (+) or decrease (−) of yields of cotton on plots previously sown with guinea corn as compared with yield on those previously sown with Groundnut.	Increase (+) or decrease (−) of yields of cotton on plots previously sown with cotton as compared with yield on those previously sown with Groundnut.
− 16	+ 12	− 22
− 34	+ 18	− 8
Average − 25 ± 69 lb. per acre.	Average + 15 ± 69 lb. per acre.	Average − 15 ± 69 lb. per acre.

Root—mean—square—difference between neighbouring control plots = 98 lb. per acre.

Cost of cultivation in man-days per acre = 91.

1927 Data :—

Cost of cultivation in man-days per acre Groundnuts — 104
Maize — 52
Guinea corn — 70
Cotton — 74

TABLE No. 4.

EXHAUSTIBILITY OF CROPS EXPERIMENT.

Plot.	Exhausting Crop Sown, 1925 and 1927.	Yield per acre, lb. 1925.		Yield per acre testing crop 1926, Guinea corn, lb.	Increase (+) or decrease (−) in yields of Guinea Corn on treatment plots as compared with yield on standard plots, lb. per acre.	Exhausting Crop, 1927 Yields, lb. per acre.	
		Standards	Treatments.			Standard	Treatment.
A27	Groundnuts ...	236		1,492		137·5	
28	Maize ...		171	950	− 341		130
29	Groundnuts ...	372		1,090		126·5	
30	Guinea corn		237	646	− 416		45
31	Groundnuts ...	360		1,034		128·5	
32	Cotton ...		152	754	− 197		98
33	Groundnuts ...	252		868		133·5	
34	Maize ...		171	912	− 215		63·5
35	Groundnuts ...	240		1,386		129·5	
36	Guinea corn		168	818	− 187		53
37	Groundnuts ...	164		624		100·5	
38	Cotton ...		160	814	+ 96		100
39	Groundnuts ...	140		812		118·5	

Varieties sown :—1925 and 1927 — As in Table No. 3.
1926 — Guinea corn — "Kaura."

Each plot ¼ acre. Ridges 4′ apart.

1926 Data.

Increase (+) or decrease (−) of yields of guinea corn on plots previously sown with maize as compared with yield on those previously sown with Groundnuts.	Increase (+) or decrease (−) of yields of guinea corn on plots previously sown with guinea corn as compared with yield on those previously sown with Groundnuts.	Increase (+) or decrease (−) of yields of guinea corn on plots previously sown with cotton as compared with yield on those previously sown with Groundnuts.
− 341	− 416	− 197
− 215	− 187	+ 96
Average − 278 ± 300 lb. per acre.	Average − 301 ∓ 300 lb. per acre.	Average − 50 ∓ 300 lb. per acre.

Root—mean—square—difference between neighbouring control plots = 423·6 lb. per acre.

Cost of cultivation in man-days per acre = 61·5.

1927 Data.

Cost of cultivation in man-days per acre — Groundnuts — 113
Maize — 34
Cotton — 63
Guinea corn — 59

TABLE No. 5.
MUCUNA VARIETY TEST.

Plots.	Variety.	Yield of hay, dried one day, per acre.		Increase (+) or decrease (−) as compared with mean of adjacent control plots.	Yield per acre of unthreshed seed (*see* footnote).
		Standards	Treatments.		
A 41	Zaria	1,192			
42	Zaria	1,640			
43	Nyasaland CN/54 ...		1,800	+ 22	1,800
44	Zaria	1,916			
45	Nyasaland CN/16 ...	6	2,920	+ 1,154	2,920
46	Zaria	1,616			
47	Nyasaland CN/73 ...		2,640	+ 782	2,640
48	Zaria	2,100			
49	Nyasaland CN/59 ...		2,280	+ 312	2,280
50	Zaria	1,836			
51	Nyasaland CN/54 ...		1,888	+ 306	1,888
52	Zaria	1,328			
53	Nyasaland CN/16 ...		1,672	+ 354	1,672
54	Zaria	1,308			
55	Nyasaland CN/73 ...		2,464	+ 642	2,456
56	Zaria	2,336			
57	Nyasaland CN/59 ...		3,736	+ 1,764	3,736
58	Zaria	1,608			
59	Nyasaland CN/54 ...		2,384	+ 388	2,392
60	Zaria	2,384			
61	Nyasaland CN/16 ...		3,080	+ 252	3,080
62	Zaria	3,272			
63	Nyasaland CN/73 ...		2,240	− 396	2,240
64	Zaria	2,000			
65	Nyasaland CN/59 ...		2,152	− 222	2,152
66	Zaria	2,748			
67	Nyasaland CN/54 ...		1,608	− 540	1,608
68	Zaria	1,548			
69	Nyasaland CN/16 ...		1,848	+ 362	1,848
70	Zaria	1,424			
71	Nyasaland CN/73 ...		2,344	+ 796	2,344
72	Zaria	1,672			
73	Nyasaland CN/59 ...		2,224	+ 492	2,224
74	Zaria	1,792			

Varieties sown :—"Zaria" – Stizolobium atropurpurea.
CN/54 – S. cinereum.
CN/16 – S. sterrimum.
CN/73 – S. Browneii.
CN/59 – S. derringianum.

Each plot ¼ acre. Ridges 4' apart.

N.B.—Half of each plot bearing a Nyasaland variety was kept for seed, half harvested as hay. (*See* last column of Table 5).

Mucuna sown 7th and 20th July. Hay harvested 24th and 25th November. Seed harvested 8th and 9th February, 1928.

Increase (+) or decrease (−) of yield of plots of CN/54 as compared with plots of "Zaria."	Increase (+) or decrease (−) of yield of plots of CN/16 as compared with plots of "Zaria."	Increase (+) or decrease (−) of yield of plots of CN/73 as compared with plots of "Zaria."	Increase (+) or decrease (−) of yield of plots of CN/59 as compared with plots of "Zaria."
+ 22	+ 1,154	+ 782	+ 312
+ 306	+ 354	+ 642	+ 1,764
+ 388	+ 252	− 396	− 222
− 540	+ 362	+ 796	+ 492
Average + 44 ± 340 lb. per acre.	Average + 531 ± 340 lb. per acre.	Average + 456 ± 340 lb. per acre.	Average + 587 ± 340 lb. per acre.

Root – mean – square – Difference between neighbouring control plots – 680·7 lb. per acre.
Cost of cultivation in man-days per acre – 47.

TABLE No. 6.

Phosphate Test.

Plot.	Treatment.	Pounds per acre of "one-day-dried" mucuna hay.		Increase (+) or decrease (−) compared with yield of adjacent control plots.
A 92	200 lb. Nigerian Rock Phosphate per acre	2,584		
92A	220 lb. Superphosphate per acre		3,664	+ 1,140
93	200 lb. Nigerian Rock Phosphate per acre	2,464		
93A	220 lb. Superphosphate per acre		4,640	+ 2,064
94	200 lb. Nigerian Rock Phosphate per acre	2,688		
94A	220 lb. Superphosphate per acre		4,448	+ 1,968
95	200 lb. Nigerian Rock Phosphate per acre	2,272		
95A	220 lb. Superphosphate per acre		3,464	+ 1,084
96	200 lb. Nigerian Rock Phosphate per acre	2,488		
96A	220 lb. Superphosphate per acre		4,544	+ 1,904
97	200 lb. Nigerian Rock Phosphate per acre	2,792		
97A	220 lb. Superphosphate per acre		3,096	+ 332
98	200 lb. Nigerian Rock Phosphate per acre	2,736		
98A	220 lb. Superphosphate per acre		3,144	+ 928
99	200 lb. Nigerian Rock Phosphate per acre	1,696		
99A	220 lb. Superphosphate per acre		2,768	+ 1,004
100	200 lb. Nigerian Rock Phosphate per acre	1,832		
100A	220 lb. Superphosphate per acre		2,424	+ 644
101	200 lb. Nigerian Rock Phosphate per acre	1,728		
101A	200 lb. Nigerian Rock Phosphate per acre	1,472		

Variety sown :—Mucuna—"Zaria."
Each plot $\frac{1}{8}$ acre. Ridges 4' apart. Sown 9th and 20th July. Harvested 28th November.

Increase (+) or decrease (−) of yield of plots receiving Superphosphate as compared with those receiving Nigerian Rock Phosphate.

+ 1,140
+ 2,064
+ 1,968
+ 1,084
+ 1,904
+ 332
+ 928
+ 1,004
+ 644

Average + 1,229·8 ± 128·7 lb. per acre.

Root—mean square—difference between neighbouring control plots—386 lb. per acre.
Cost of cultivation in man-days per acre—37·8.

TABLE No. 7.

Manurial Experiment.

Plot.	Treatment.	lb. per acre guinea-corn on head.		Increase (+) or decrease (−) from mean of adjacent controls plots.	
Block 1	Standard	1,716			
1A	Treatment A		1,306	...	− 398
2	Standard	1,691			
2A	Treatment B		875	...	− 760
3	Standard	1,578			
3A	Treatment C		1,349	...	− 268
4	Standard	1,656			
4A	Treatment D		1,383	...	− 232
5	Standard	1,574			
5A	Treatment E		1,825	...	+ 357
6	Standard	1,361			
6A	Treatment A		1,045	...	− 521
7	Standard	1,771			
7A	Treatment B		996	...	− 738
8	Standard	1,696			
8A	Treatment C		1,671	...	+ 39
9	Standard	1,567			
9A	Treatment D		959	...	− 679
10	Standard	1,709			
10A	Treatment E		1,982	...	+ 289
11	Standard	1,677			
11A	Treatment A		1,435	...	− 204
12	Standard	1,600			
12A	Treatment B		683	...	− 831
13	Standard	1,428			
13A	Treatment C		1,144	...	− 177
14	Standard	1,214			
14A	Treatment D		938	...	− 439
15	Standard	1,539			
15A	Treatment E		1,433	...	− 17
16	Standard	1,361			
16A	Treatment A		983	...	− 330
17	Standard	1,264			
17A	Standard	1,318			

Standard: −3 tons pen manure per acre.

Treatment A. 200 lb. Nigerian Rock Phosphate per acre.

Treatment B. Unmanured.

Treatment C. 200 lb. Nigerian Rock Phosphate + 75 lb. Sulphate of Ammonia per acre.

Treatment D. 200 lb. Nigerian Rock Phosphate + 60 lb. Muriate of Potash per acre.

Treatment E. 3 tons pen manure + 200 lb. Nigerian Rock Phosphate per acre.

Variety sown:— Guinea corn—"Kaura".

Each plot $\frac{1}{8}$ acre. Ridges 4' apart. Sown 1st and 24th May. Harvested 28th November.

TABLE No. 7—*continued.*

Increase (+) or decrease (−) of yield of plots receiving 200 Nigerian Rock Phosphate as compared with those receiving 3 tons per acre pen manure.	Increase (+) or decrease (−) of yield of plots receiving 200 Nigerian + 75 S/A as compared with those receiving 3 tons per acre pen manure.	Increase (+) or decrease (−) of yield of plots receiving Farm Yard Manure + 200 Nigerian Rock Phosphate as compared with those receiving 3 tons per acre pen manure.
− 398	− 268	+ 357
− 521	+ 39	+ 289
− 204		
− 330	− 177	− 17
4 | − 1,453	3 | − 406	3 | + 629
Average { − 363 ± 89·3 lb. per acre.	Average { − 135 ± 103·7 lb. per acre.	Average { + 210 ± 103·7 lb. per acre.

Increase (+) or decrease (−) of yield of plots receiving No Manure as compared with those receiving 3 tons per acre pen manure.	Increase (+) or decrease (−) of yield of plots receiving 200 Nigerian Rock Phosphate + 60 K/C as compared with those receiving 3 tons per acre pen manure.
− 760	− 232
− 738	− 679
− 831	− 439
3 | − 2,329	3 | − 1,350
Average − 776 ± 103·7 lb. per acre.	Average − 450 ± 103·7 lb. per acre.

Root—mean—square—difference between neighbouring control plots = 178·5 lb. per acre. Cost of cultivation in man-days per acre = 53.

TABLE No. 8.

GERO AND MUCUNA FOR FODDER.

Plot.	Gero yield lb. per acre ("on head").	Mucuna yield per acre as "one-day-dried" hay.		Increase (+) or decrease (−) from mean of adjacent control plots.
		Standards.	Treatments.	
B 36	600	316		
37	884		660	... + 256
38	940	492		
39	840		556	... − 122
40	964	864		
41	810		580	... − 224
42	840	744		
43	668		720	... + 24
44	668	648		
45	632		332	... − 116
46	436	248		
47	524		420	... + 159
48	548	292		
49	536		180	... − 86
50	452	240		
51	368		220	... + 6
52	448	188		
53	532		376	... + 104
54	612	356		
55	524		544	... + 162
56	792	408		
57	452		624	... + 168
58	444	504		
59	372		388	... − 12
60	356	296		
61	344		324	... − 26
62	336	404		
63	364		336	... − 14
64	444	296		
65	440		376	... + 96
66	596	264		

Varieties sown:—Gero —"Zango" —Mucuna —"Zaria".
Each plot ¼ acre. Ridges 4' apart.

Gero sown 19th April, harvested 3rd & 4th August.

Mucuna sown 4th July, harvested 30th November.

Increase (+) or decrease (−) of yield of plots where Gero was cut 2' high as compared with yield on those where Gero was cut at ground level, lb. per acre of "one-day-dried" hay.

+ 256
− 122
− 224
+ 24
− 116
+ 150
− 86
+ 6
+ 104
+ 162
+ 168
− 12
− 26
− 14
+ 96

Root—mean—square—difference between neighbouring control plots=176·7 lb. per acre.

Cost of cultivation in man-days per acre—Gero—19·0, Mucuna—28·1.

Average increase + 24·4 ± 45·6 lb. per acre.

TABLE No. 9.

Fodder Crop Experiment.

Plot.	1926. Gero, lb. per acre "on head" All plots.	1926. Guineacorn, lb. per acre "on head" standard plots only.	1926. Mucuna, lb. per acre, hay, treatment plots only.	1926. Treatment given to Mucuna on treatment plots.	1927. Yield of guineacorn on head, lb. per acre. Standards treatment.	Increase (+) or decrease (−) compared with mean of adjacent controls, lb. per acre.
C 1	508	1,282			854	
2	928		2,564	Removed entirely and FYM equivalent returned	1,536	+ 573
3	736	974			1,072	
4	692		2,464	Removed entirely	1,124	+ 146½
5	492	1,144			883	
6	800		...	Turned in for Green Manure	1,174	+ 457
7	296	858			551	
8	604		...	Folded on plots in November	675	− 6½
9	456	996			812	
10	528		1,340	Removed entirely and FYM equivalent returned	993	+ 195½
11	292	942			783	
12	332		1,656	Removed entirely	607	− 50
13	352	836			531	
14	368		...	Turned in for Green Manure	829	+ 310
15	532	832			507	
16	408		...	Folded on plots in November	844	+ 183½
17	544	948			814	
18	228		1,708	Removed entirely and FYM equivalent returned	1,203	+ 393½
19	532	914			805	
20	536		1,576	Removed entirely	1,236	+ 378½
21	436	1,140			910	
22	1,104		...	Turned in for Green Manure	1,485	+ 636
23	956	998			788	
24	1,328		...	Folded on plots in November	1,154	+ 415
25	640	700			690	
26	376		1,476	Removed entirely and FYM equivalent returned	801	+ 297½
27	344	566			317	
28	408		1,188	Removed entirely	707	+ 346
29	428	484			405	
30	484		...	Turned in for Green Manure	1,126	+ 680
31	208	648			487	
32	404		...	Folded on plots in November	579	+ 102
33	292	616			467	

TABLE No. 9—*continued.*

Increase of yield of guineacorn after removal of a crop of mucuna and return of its Farm Yard Manure equivalent as compared with yield of guineacorn after removal of a crop of guineacorn ("Mucuna B").

+ 573
+ 195½
+ 393½
+ 297½
Average + 365 ± 97·7 lb. per acre.

Increase of yield of guineacorn after removal of a crop of mucuna as compared with yield of guineacorn after removal of a crop of guineacorn.

+ 146½
− 50
+ 378½
+ 346
Average + 205 ± 97·7 lb. per acre.

Increase of yield of guineacorn after turning in a crop of mucuna for green manure as compared with yield of guineacorn after removal of a crop of guineacorn.

+ 457
+ 310
+ 636
+ 680
Average + 521 ± 97·7 lb. per acre.

Increase of yield of guineacorn after folding a crop of mucuna on land in the previous November as compared with yield of guineacorn after removal of a crop of guineacorn.

− 6½
+ 183½
+ 415
+ 102
Average + 174 ± 97·7 lb. per acre.

Root—mean—square—difference between neighbouring "control" plots—(gero, 1926) = 219·1 lb. per acre.

Root—mean—square—difference between neighbouring control plots—(guineacorn, 1927) = 195·3 lb. per acre.

Cost of cultivation of guineacorn (1927) in man-days per acre = 65·6.

TABLE No. 9A.

FODDER CROP EXPERIMENT.

Recovery of "Corn" on Treatment Plots.

Plot.	1926. Gero. Increase (+) or decrease (—) compared with mean of gero yield of adjacent control plots.	1926. Mean of adjacent guineacorn plots, *i.e.*, estimated loss of guineacorn forfeited by growing mucuna.	1926. Nett weight of corn forfeited by growing mucuna.	1927. Guineacorn recovered. Increase (+) or decrease (—) compared with mean of adjacent control plots.	Balance still to be recovered after second year.
C 2	+ 306	1,128	822	+ 573	249
4	+ 78	1,059	981	+ 126	855
6	+ 406	1,001	595	+ 457	138
8	+ 228	927	699	— 106	805
10	+ 154	969	815	+ 195	620
12	+ 10	889	879	— 50	929
14	— 74	834	908	+ 310	598
16	— 130	870	1,000	+ 183	817
18	— 310	931	1,241	+ 393	848
20	+ 52	1,027	975	+ 378	597
22	+ 408	1,069	661	+ 636	25
24	+ 530	849	319	+ 415	— 96
26	— 116	633	749	+ 297	452
28	+ 22	525	503	+ 346	157
30	+ 166	566	400	+ 680	— 280
32	+ 154	632	478	+ 102	376

Balance of corn still to be recovered after "Mucuna B".

249
620
848
452

Average 542 lb. per acre.

Balance of corn still to be recovered after "Mucuna C".

855
929
597
157

Average 634 lb. per acre.

Balance of corn still to be recovered after "Mucuna D".

138
598
25
— 280*

Average 120 lb. per acre.

Balance of corn still to be recovered after "Mucuna E".

805
817
— 96*
376

Average 475 lb. per acre.

* *i.e.* excess already recovered.

TABLE No. 10.

GERO AND MUCUNA FOR FODDER.

Plot.		Gero yield lb. per acre ("on head"	MUCUNA YIELD PER ACRE AS "ONE-DAY-DRIED" HAY, LB.		Increase (+) or decrease (−) from mean of adjacent control plots.
			Standards.	Treatment.	
C	34	884	1,300		
	35	864		1,376	+ 216
	36	808	1,020		
	37	812		1,860	+ 834
	38	548	1,032		
	39	444		1,164	+ 232
	40	408	832		
	41	388		948	+ 174
	42	460	716		
	43	352		720	− 122
	44	488	968		
	45	416		936	+ 68
	46	400	768		
	47	352		936	+ 178
	48	328	748		
	49	352		588	− 140
	50	280	708		
	51	224		488	− 38
	52	172	344		
	53	304		1,020	+ 450
	54	328	796		
	55	428		944	+ 64
	56	308	964		
	57	264		928	+ 80
	58	204	732		
	59	352		952	+ 88
	60	504	996		
	61	476		936	− 96
	62	392	1,068		
	63	292		500	− 416
	64	364	764		
	65	544		912	+ 144
	66	528	772		

Varieties sown :—Gero — "Wayan Bijimi", Mucuna — "Zaria". Each plot ¼ acre. Ridges 4' apart.
Gero sown 19th April. Harvested 4th August. Mucuna sown 5th July. Harvested 30th November.

Increase (+) or decrease (−) of yield of mucuna plots where gero was cut 2' high as compared with yield on those where gero was cut at ground level, lb. per acre of "one-day-dried" hay.

+ 216
+ 834
+ 232
+ 174
− 122
+ 68
+ 178
− 140
− 38
+ 450
+ 64
+ 80
+ 88
− 96
− 416
+ 144

Average increase + 107·3 ± 56·7 lb per acre.

Root-mean-square-difference between neighbouring control plots — 226·9 lb. per acre.
Cost of cultivation in man-days per acre — Gero = 17·1.
— Mucuna = 23·5.

TABLE 11.

Stale Ridge Experiment.

Plot.	Treatment before sowing.	Yield in lb. of seed cotton per acre.		Increase (+) or decrease (−) from mean of adjacent control.
		Standards.	Treatment.	
D 1	Ridged	159		
2	Not Ridged ...		147	− 32
3	Ridged	199		
4	Not Ridged ...		188	− 12
5	Ridged	201		
6	Not Ridged ...		140	− 27
7	Ridged	133		
8	Not Ridged ...		86	− 47
9	Ridged	133		
10	Not Ridged ...		88	− 67
11	Ridged	177		
12	Not Ridged ...		112	− 36
13	Ridged	119		
14	Not Ridged ...		81	− 63
15	Ridged	170		
16	Not Ridged ...		118	− 45
17	Ridged	157		
18	Not Ridged ...		127	− 41
19	Ridged	179		
20	Not Ridged ...		95	− 76
21	Ridged	163		
22	Not Ridged ...		170	− 10
23	Ridged	197		
24	Not Ridged ...		89	− 114
25	Ridged	209		
26	Not Ridged ...		152	− 30
27	Ridged	156		
28	Not Ridged ...		107	− 42
29	Ridged	142		
30	Not Ridged ...		164	+ 1
31	Ridged	184		
32	Not Ridged ...		135	− 22
33	Ridged	131		

Variety sown :—Cotton—"Allen—M I". Each plot ¼ acre. Ridges 4' apart.
Cotton sown 27th June. Picked 6th December, 3rd January (1928) 1st February (1928).

Increase (+) or decrease (−) of yield of cotton on plots not ridged before sowing as compared with yield on plots ridged before sowing, lb. per acre.

− 32
− 12
− 27
− 47
− 67
− 36
− 63
− 45
− 41
− 76
− 10
− 114
− 30
− 42
+ 1
− 22

Average − 41·4 ± 9·67 lb per acre.

Root mean square difference between neighbouring control plots—38·7 lb. per acre.
Cost of cultivation in Man-days per acre = 62·7.

TABLE No. 12.

GROUNDNUT VARIETY TEST.

Plot.	Variety.	Yield lb. per acre unthreshed.		Increase (+) or decrease (−) as compared with mean of adjacent controls.
		Standards.	Treatment.	
D 34	Zaria	590		
35	Chinese ...		574	− 71
36	Zaria	700		
37	American ...		902	+ 198
38	Zaria	708		
39	Chinese ...		668	− 115
40	Zaria	858		
41	American ...		962	+ 110
42	Zaria	846		
43	Chinese ...		1,236	+ 306
44	Zaria	1,014		
45	American ...		996	+ 8
46	Zaria	962		
47	Chinese ...		1,012	− 3
48	Zaria	1,068		
49	American ...		818	− 130
50	Zaria	828		
51	Chinese ...		970	+ 261
52	Zaria	710		
53	American ...		350	− 455
54	Zaria	920		
55	Chinese ...		768	− 66
56	Zaria	748		
57	American ...		929	− 11
58	Zaria	1,118		
59	Chinese ...		690	− 405
60	Zaria	1,074		
61	American ...		841	109
62	Zaria	832		
63	Chinese ...		746	90
64	Zaria	840		
65	American ...		354	− 498
66	Zaria	854		

Varieties sown :– (*see* above)
Each plot ¼ acre. Ridges 4' apart.

Increase (+) or decrease (−) of yield of Chinese groundnuts as compared with Zaria groundnuts, unthreshed.	Increase (+) or decrease (−) of yield of American groundnuts as compared with Zaria groundnuts, unthreshed.
− 71	+ 198
− 115	+ 110
+ 306	+ 8
− 3	− 110
+ 201	− 455
− 66	− 11
− 406	− 109
− 90	− 498
Average − 30·5 ± 57·3 lb per acre.	Average − 111 ± 57·3 lb per acre.

Root–mean–square–difference between neighbouring control plots. 162 lb per acre.
Cost of cultivation in Man-days per acre = 56.

TABLE No. 13.

Farm Yard Manure *v.* Kraaling Experiment.

Plot.	Treatment:	1926. Yield per acre seed cotton.	1926. Increase (+) or decrease (−) as compared with mean of adjacent controls.	1927. Yield per acre, guineacorn "on head."	1927. Increase (+) or decrease (−) as compared with mean of adjacent controls.
E 34	400 Cattle Nights Kraaling ...	136		866	
35	100 CN Farm Yard Manure . .	172	− 12	894½	− 120½
36	400 Cattle Nights Kraaling ...	232		1,163½	
37	200 CN Farm Yard Manure ...	252	+ 16	1,144	− 17
38	400 Cattle Nights Kraaling ...	240		1,158	
39	300 CN Farm Yard Manure ...	216	− 28	1,140	+ 19
40	400 Cattle Nights Kraaling ...	248		1,083½	
41	400 CN Farm Yard Manure ...	264	− 34	1,188	− 58
42	400 Cattle Nights Kraaling ...	348		1,409	
43	100 CN Farm Yard Manure ...	300	− 4	1,017	− 399
44	400 Cattle Nights Kraaling ...	260		1,422	
45	200 CN Farm Yard Manure ...	332	+ 36	1,302	− 23
46	400 Cattle Nights Kraaling ...	332		1,227½	
47	300 CN Farm Yard Manure ...	344	+ 44	1,216½	+ 133½
48	400 Cattle Nights Kraaling ...	268		938½	
49	400 CN Farm Yard Manure ...	344	+ 90	1,368½	+ 416½
50	400 Cattle Nights Kraaling ...	240		966	
51	100 CN Farm Yard Manure ...	220	− 48	871	− 180
52	400 Cattle Nights Kraaling ...	296		1,135½	
53	200 CN Farm Yard Manure ...	292	− 8	1,111½	− 135½
54	400 Cattle Nights Kraaling ...	304		1,359	
55	300 CN Farm Yard Manure ...	412	+ 138	1,313½	+ 86½
56	400 Cattle Nights Kraaling ...	244		1,095½	
57	400 CN Farm Yard Manure ...	372	+ 130	1,415	+ 289
58	400 Cattle Nights Kraaling ...	240		1,157	
59	100 CN Farm Yard Manure ...	296	+ 34	1,125½	− 87½
60	400 Cattle Nights Kraaling ...	284		1,268	
61	200 CN Farm Yard Manure ...	300	+ 10	1,179½	− 81½
62	400 Cattle Nights Kraaling ...	296		1,254½	
63	300 CN Farm Yard Manure ...	268	− 14	1,294	− 38
64	400 Cattle Nights Kraaling ...	268		1,410	
65	400 CN Farm Yard Manure ..	392	+ 134	1,684	+ 322
66	400 Cattle Nights Kraaling ...	248		1,313	

Varieties sown :—1926. Cotton, Allen M 1.
1927. Guineacorn, "Kaura."

Each plot ¼ acre. Ridges 4' apart.

1926. Cotton sown 12th July. Picked 10th and 27th December, 19th January (1927).

1927. Guineacorn sown 28th April. Harvested 22nd and 30th November.

Increase (+) or decrease (−) of yields of (I) cotton (1926) and (II) guineacorn (1927) on plots receiving 100 Cattle Nights Farm Yard Manure as compared with yields on plots receiving 400 Cattle Nights Kraaling.

(I)	(II)
− 12	− 120½
− 4	− 399
− 48	− 180
+ 34	− 87½
Average −7·5 ± 27 lb. per acre.	Average −197 ± 90·16 lb. per acre.

Increase (+) or decrease (−) of yields of (I) cotton (1926) and (II) guineacorn (1927) on plots receiving 200 Cattle Nights Farm Yard Manure as compared with yields on plots receiving 400 Cattle Nights Kraaling.

(I)	(II)
+ 16	− 17
+ 36	− 23
− 8	− 135½
+ 10	− 81½
Average +13·5 ± 27 lb. per acre.	Average −64 ± 90·16 lb. per acre.

TABLE No. 13—*continued.*

Increase (+) or decrease (−) of yields of (I) cotton (1926) and (II) guineacorn (1927) on plots receiving 300 Cattle Nights Farm Yard Manure as compared with yields on plots receiving 400 Cattle Nights Kraaling.

(I)	(II)
− 28	+ 19
+ 44	+ 133½
+ 138	+ 86½
− 14	− 38
Average + 35 ± 27 lb. per acre.	Average + 50 ± 90·16 lb. per acre.

Increase (+) or decrease (−) of yields of (I) cotton (1926) and (II) guineacorn (1927) on plots receiving 400 Cattle Nights Kraaling.

(I)	(II)
− 34	− 58
+ 90	+ 416½
+ 130	+ 289
+ 134	+ 332
Average + 80 ± 27 lb. per acre.	Average +245 − 90·16 lb. per acre.

Root—mean—square—difference between neighbouring control plots (cotton, 1926) − 54·3 lb. per acre.

Root—mean—square—difference between neighbouring control plots (guineacorn, 1927) − 180·3 lb. per acre.

COSTS OF CULTIVATION IN MAN-DAYS PER ACRE.

	Cotton growing, 1926.	Guineacorn growing, 1927.	Kraaling or Manuring.	Total for both crops.
Standards	85	29·2	4·0	118·2
100 Cattle Nights F.Y.M. ...	85	29·2	2·1	116·3
200 „ „ „ ...	85	29·2	4·2	118·4
300 „ „ „ ...	85	29·2	6·3	120·5
400 „ „ „ ...	85	29·2	8·4	122·6

MARKET VALUE OF CROPS HARVESTED.

Cotton at 2¼d. per lb. Guineacorn at 3s. 5d. per lb.

	Cotton, 1926 per acre.	Guineacorn, 1927 per acre.	Total, 1926 and 1927 per acre.	Total as man-days per acre.
	£ s. d.	£ s. d.	£ s. d.	
Standards	2 9 6	2 19 6	5 9 0	145·3
100 CN Farm Yard Manure...	2 8 1	2 9 8	4 17 9	130·3
200 „ „ „ „ ...	2 12 0½	2 16 3½	5 8 4	144·4
300 „ „ „ „ ...	2 16 1	3 2 0	5 18 1	157·4
400 „ „ „ „ ...	3 4 6	3 11 9	6 16 3	181·6

TABLE No. 14.

Cotton Cultivation Experiment (*a*).

Plot.	Treatment.	Yield of seed cotton in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent control plots.
Bomo A 1	Standard	124	
2	Treatment P	145	− 16
3	Standard	199	
4	Treatment P	141	− 41
5	Standard	165	
6	Treatment P	165	− 3
7	Standard	172	
8	Treatment P	153	− 43
9	Standard	220	
10	Treatment P	155	− 28
11	Standard	146	
12	Treatment P	117	− 35
13	Standard	159	
14	Treatment P	107	− 63
15	Standard	182	
16	Treatment P	91	− 118
17	Standard	236	

Variety grown :—Cotton-Allen M 1—Cultivation *see* paragraph 35.
Each plot ¼ acre. Ridges 4′ apart.
Cotton sown 2nd July. Picked 17th and 19th December, 7th and 9th January (1928).

SPECIAL CULTIVATIONS.

	Standards.	Treatment P.
Hoeing ...	30th and 31st July	30th and 31st July
Hoeing ...	22nd August	—
Ridging ...	—	1st and 3rd September
Hoeing ...	15th September	—
Mulching ...	21st, 22nd and 24th October	—

Increase (+) or Decrease (−) of yield of cotton on "Treatment P" plots as compared with that on standards, lb. per acre.

− 16
− 41
− 3
− 43
− 28
− 35
− 63
− 118

Average − 43·4 ± 16·9 lb. per acre.

Root—mean—square—difference between neighbouring control plots—47·7 lb. per acre.
Average yield of 9 standard plots—178·1 lb. per acre.
Cost of cultivation in man-days per acre
Standards :—63·4
Treatment P :—36·7
Value of crops harvested (at 2¼d. per lb.) per acre.
Standards —£1 13s. 5d. = 44·6 Man-days.
"Treatment P"—£1 5s. 3d. = 33·7 Man-days.

TABLE No. 15.

Cotton Cultivation Experiment (*b*).

Plot.	Treatment.	Yield of seed cotton in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent control plots.
Bomo A 18	Standard	180	
19	Treatment Q ...	198	− 7
20	Standard	230	
21	Treatment R ...	162	− 19
22	Standard	133	
23	Treatment Q ...	143	− 1
24	Standard	156	
25	Treatment R ...	196	+ 12
26	Standard	212	
27	Treatment Q ...	202	+ 10
28	Standard	172	
29	Treatment R ...	182	+ 13
30	Standard	166	
31	Treatment Q ...	168	+ 12
32	Standard	147	
33	Non experimental ...	108	

Variety grown :—Cotton—Allen—M1.

Cultivations :—*see* paragraph 36.

Each plot $\frac{1}{4}$ acre. Ridges 4′ apart.

Cotton sown :—2nd and 14th July. Picked :—17th and 19th December, 7th and 9th January (1928), 3rd February (1928).

SPECIAL CULTIVATIONS.

	Standards.	Treatment Q.	Treatment R.
Hoeing	30th and 31st July	30th and 31st July	30th and 31st July
Hoeing	22nd August ...	22nd August ...	22nd August.
Hoeing	15th September ...	15th September ...	15th September.
Weeding ...	—	—	21st and 22nd Oct.
Mulching ...	22nd—26th October	—	—

TABLE No. 15—*continued.*

Increase (+) or decrease (−) of yield of cotton on "Treatment Q" plots as compared with that on standard plots, lb. per acre.	Increase (+) or decrease (−) of yield of cotton on "Treatment R" plots as compared with that on standard plots, lb. per acre.
− 7	− 19
− 1	+ 12
+ 10	+ 13
+ 12	
Average + 3·5 ± 25·05 lb. per acre.	Average + 2·0 ± 28·93 lb. per acre.

Root—mean—square—difference of neighbouring control plots — 50·1 lb. per acre.

Average yield of 8 standard plots = 174·5 lb. per acre.

Cost of cultivation in Man-days per acre :—

Standard − 59.4

"Treatment Q" − 46·7

"Treatment R" − 56·3

Value of crops harvested (at 2¼d. per lb.) per acre.

Standard — £1 12s. 9d. = 43·6 Man-days

"Treatment Q" — £1 13s. 5d. = 44·6 ,,

"Treatment R" − £1 13s. 1d. = 44·1 ,,

TABLE No. 16.

Cotton Strain Test.

Plot.		Strain.	Yield per acre, lb. of seed cotton.		Increase (+) or decrease (−) compared with mean of adjacent controls.
Bomo E	1	M1	177		
	2	Botanists D		249	+ 36
	3	M1	249		
	4	Botanists E		249	− 6
	5	M1	261		
	6	Botanists D		296	+ 20½
	7	M1	290		
	8	Botanists E		262	− 26
	9	M1	286		
	10	Botanists D		153	− 97
	11	M1	214		
	12	Botanists E		219	− 34
	13	M1	292		
	14	Botanists D		242	− 31½
	15	M1	255		
	16	Botanists E		237	− 35½
	17	M1	290		
	18	Botanists D		248	− 3½
	19	M1	213		
	20	Botanists E		238	− 0½
	21	M1	264		
	22	Botanists D		212	− 12
	23	M1	184		
	24	Botanists E		224	− 56
	25	M1	376		
	26	Botanists D		235	− 22
	27	M1	238		
	28	Botanists E		258	0½
	29	M1	277		
	30	Botanists D		299	+ 45½
	31	M1	230		
	32	Botanists E		203	+ 21
	33	M1	134		

Variety sown :- Cotton—Allen M1 and strains as above. Each plot ¼ acre. Ridges 4' apart. Cotton sown 1st July. Picked 1st, 20th and 21st December, 10th and 11th January (1928).

Increase (+) or decrease (−) of yield of cotton on plots growing Botanist's Strain D as compared with yield on these growing Strain M1, lb. per acre.

+ 36
+ 20½
− 97
− 31½
− 3½
− 12
− 22
+ 45½

Average − 8 ± 25·95 lb. per acre.

Increase (+) or decrease (−) of yield of cotton on plots growing Botanist's Strain E as compared with yield on those growing Strain M1, lb. per acre.

− 6
− 26
− 34
− 35½
− 0½
− 56
+ 0½
+ 21

Average − 17·1 ± 25·95 lb. per acre.

Root—mean—square—difference between neighbouring control plots − 73·4 lb. per acre.
Cost of cultivation in man-days per acre − 54·1.

TABLE No. 17.

Cotton Disinfection Experiment (Bomo C).

Plot.	Guineacorn plots, yields per acre.	Seed cotton yields, lb. per acre.	Increase (+) or decrease (−) of yields of cotton on treatment plots as compared with mean of adjacent standard plots.
Bomo C 1	1,296		
I.		280	
2	1,420		
II		292	+ 20
3	1,444		
III		264	
4	1,516		
IV		312	+ 24
5	1,668		
V		312	
6	1,188		
VI		248	− 70
7	1,420		
VII		324	
8	560		
VIII		180	− 107
9	560		
IX		250	
10	292		

The yields of the guineacorn belts were :—

North belt at the rate of 833 lb. per acre.

South „ „ 935 „ „

Variety sown : Guineacorn—"Kaura".

Cotton—Allen—Daudawa seed.

Each guineacorn plot ¼ acre. Ridges 4' apart.

Each cotton plot ⅛ acre. Ridges 4' apart.

Guineacorn sown 13th May. Harvested 22nd November.

Cotton sown 23rd July. Picked 19th December, 13th January (1928).

Increase (+) or decrease (−) of yields of cotton from "disinfected-seed plots" as compared with that from standard plots.

+ 20
+ 24
70
− 107

Average − 33·2 ± 22·6 lb. per acre.

Root—mean—square difference between neighbouring cotton control plots—44·2 lb. per acre

Costs of cultivation in man-days per acre—Guineacorn—72·9.

Cotton—56·1

Average yield per acre of Guineacorn—1,064 lb.

TABLE No. 18.

Cotton Disinfection (Poultry Pen Plot).

Plot.	Guineacorn plots, yields per acre.	Seed cotton yields, lb. per acre.	Increase (+) or decrease (−) of yields of cotton on treatment plots as compared with mean of adjacent standard plots.
Poultry Pen 1	712		
I		100	
2	896		
II		120	+ 20
3	868		
III		100	
4	664		
IV		108	+ 10
5	508		
V		96	
6	756		
VI		156	+ 44
7	616		
VII		128	
8	680		
VIII		120	+ 12
9	600		
IX		88	
10	268		

The yields of the guineacorn belts were :—
East belt at the rate of 496 lb. per acre.
West belt at the rate of 629 lb. per acre.

Varieties sown :—Guineacorn—"Kaura".
Cotton—Allen—Daudawa seed.

Each guineacorn plot ¼ acre. Ridges 4' apart.

Each cotton plot ⅛ acre. Ridges 4' apart.

Guineacorn sown 8th May. Harvested 22nd November.

Cotton sown 23rd July. Picked 23rd December, 14th January (1928).

Increase (+) or decrease (−) of yields of cotton from "disinfected-seed plots" as compared with that from standard plots.

+ 20
+ 10
+ 44
+ 12

Average + 21·5 ± 12·85 lb. per acre.

Root–mean–square–difference between neighbouring cotton control plots—25·69 lb. per acre

Costs of cultivation in man-days per acre—Guineacorn—56·9.
Cotton—49·3.

Average yield per acre of guineacorn—635·6 lb.

TABLE No. 19.

Costs of Cultivation of Crops for Season, 1927–28 in Man-days per acre.

Crop.	Preparation.	Sowing and Establishing.	After cultivation.	Picking or Harvesting.	Sundry costs, mostly watching.	Total cost.
Cotton alone ...	11·8	3·0	28·2	11·8	14·8	69·6
Groundnuts alone	16·8	4·2	15·9	71·2	41·8	149·9
Guineacorn alone	6·9	6·0	21·9	7·0	1·8	43·6
Beans alone ...	14·8	3·6	6·9	1·4	0·8	27·5
Maize alone ...	11·9	7·8	17·2	8·0	...	45·1
Mucuna alone ...	23·1	3·7	9·8	4·1	...	40·7
Mucuna (as Early Green Manure) and Cotton after ...	13·7	18·2	(*a*) ...	...	...	31·9
Gero ... ... and (*b*) Mucuna	9·9 ...	1·8 4·2	22·5 6·4	15·1 7·3	... ...	49·3 17·9
	6·4	1·9	16·3	(*c*) 1·0	...	25·6

Note:—(*a*) Cost of ridging—in the mucuna charged as preparation for cotton following.

(*b*) Cultivation costs shared during period when both crops were on land, at other times to the occupying crop.

(*c*) Mucuna cut as hay. Cost of removal from field not included.

TABLE No. 20.

Comparison of Cost of Production and Revenue from Main Crops, 1927–28.

Crop.	Cost in Man-days per acre.	Average yield in lb. per acre.	Cost in Man-days per lb.	Assumed Market value per lb. in same condition.	Calculated Return per acre, including transport to market.	Gross money return per Man-day in pence. (Not profit.)	Condition of Crop.
					£ s. d.		
Cotton alone	69·6	169.6	·410	2·375	1 11 4	5·40	Seed Cotton.
Groundnuts alone ...	149·9	631·6	·237	0·60	1 4 1	1·93	Undecorticated.
Guineacorn alone ...	43·6	953·4	·046	0·4	1 11 9	8·75	Grain on head.
Beans alone	27·5	240·7	·114	No data	...	...	Undecorticated.
Maize alone	45·1	255·9	·176	0·5	0 7 8	2·04	Grain on head.
Mucuna alone	40·7	2,402·0	·017	...	Fodder, not sold	...	Dried hay.
Mucuna (as Early Green Manure) and ...	31·9	...	...	...	Not marketed	6·39	(Turned in).
Cotton after	49·3	233·7	0·211	2·375	2 3 3		Seed Cotton.
Gero and	17·9	491·4	0·036	0·4	0 10 5	6·96	
Mucuna	25·6	671·0	0·038	...	Not sold	...	Dried hay.

ANNUAL REPORT, KANO PLANTATION, 1927.

BY

E. T. HOLMES.

Total area of farm 160 acres.
Total cultivated area 140¼ acres.
Rainfall for 1927 39.26 inches.
Average rainfall over a period of six years 30.95 inches.

RAINFALL.

The rainfall was heavier than usual, being six inches greater than in 1926, which, however, was rather below the average. On the whole the rainfall was well distributed, but August and September were both very wet months. The heavy rain in August affected adversely the yields of both cotton and ground nuts, as on some days the crops were standing in water.

GENERAL.

On the whole, the crops were better than in 1926, due no doubt to the fact that a greater amount of manure was applied to the soil and to the favourable rainfall. Under the influence of increasing quantities of farm yard manure the fertility of the soil all over the farm is gradually being improved, and heavier yields may be anticipated in the future.

Ground nuts were a very even crop and yielded well, while guinea corn gave excellent yields on those parts of the farm which had been manured. Cotton yields, while not as good as those obtained last season, were quite up to the average.

CULTIVATION.

Mention was made in last year's report of the fact that cultivation by means of bullock-drawn implements had been tried and that the results were encouraging. The progress made in this direction has been one of the features of the present season and the greater part of the farm was cultivated by this means.

The bullocks take kindly to the work, and a number of labourers have been trained to handle them.

The chief difficulty at first was to find suitable implements. English-made ploughs and implements do satisfactory work but are much too expensive; and it was realised that if bullock cultivation was to make any headway among the local farmers, the first essential was to devise a simple wooden plough which could be made by village carpenters and blacksmiths. Considerable progress was made in this direction and during the season locally-made wooden ploughs were in constant use, in fact English implements were latterly discarded entirely. These implements are far from perfect, and new improved types are now being devised but it is satisfactory to be able to record that those in use were capable of doing the work.

Farmers Tests.

A portion of the farm was set aside and divided into four holdings for selected native farmers. The object of this scheme was to demonstrate the superiority of mixed farming over ordinary hand cultivation and to demonstrate the value of bullocks for draught purposes as well as for the production of farm yard manure. Two of these farmers were given nine acres of land, two bullocks, a plough and a cultivator. They were, as far as possible, allowed to grow whatever crop they liked, but advice was given as to the most suitable acreage under each crop, and it was necessary to insist that a certain area should be devoted to the growing of fodder crops for the cattle. The other two farmers were each given four and a half acres of land which is the normal acreage of the average farm in the Kano area. They were allowed to farm exactly as they wished and in the ordinary native style.

At the end of the season a comparison of the two methods was made, and it was demonstrated that the farmers using bullocks could easily cultivate twice as much land as those farming by ordinary native methods. These tests are being continued, but the hand cultivation is being discarded and the land from these two holdings is being given to a third farmer who will use bullocks. The most important point has yet to be demonstrated namely that by means of the manure made by the cattle and supplemented by bedding. this increased acreage can be maintained in a fair state of fertility.

During the coming season each farmer will also be given a cow in order to complete his homestead.

Fodder Crops.

A large area of the farm was cropped with mucuna for cattle fodder, but the yields were disappointing. The best results were obtained from that sown in mid-June and the poor yields were possibly due to the fact that much of it was sown too early. A time

of planting experiment will be carried out this season in order to test this point. Mucuna still appears to be the most suitable crop for fodder, and we have been unable to find any other crop which is likely to take its place.

Manurial Experiments.

In a thickly populated area such as Kano, where shifting cultivation is almost impossible, if good crops are to be grown year after year some form of manuring is essential. The native already realises this and manures his land either by " kraaling " or by the application of town manure supplemented by the manure made by the goats and small stock around his homestead.

In view of the success obtained by the use of artificial manures in other countries it was only natural to suppose that they might be of value here, but it has to be borne in mind that if they are to be of any real use the increase in the crop must be sufficient to make up for the extra expense incurred in their purchase. The only form of artificial manure found in Nigeria is Rock Phosphate, so that it is the only one which is likely to be at all profitable. Others such as nitrate of soda, etc., have to be imported from England and their cost would therefore prohibit their use to any great extent.

An alternative to the use of artificials and one which we are now testing is the introduction of mixed farming and the systematic making of F.Y.M. in each homestead. Such a system if introduced generally would make the farmer independent of the Fulani herds which are used for kraaling and give him a supply of good but cheap manure.

A series of manurial experiments were therefore started to test whether phosphate alone, or either in combination with other artificials, or F.Y.M. would be worth recommending to the natives. From the results so far obtained it would appear that very little advantage is gained by the application of phosphate alone or phosphate in combination with other artificials, but there is some evidence to show that phosphate in combination with F.Y.M. gives a slightly better yield than F.Y.M. alone, but the gain in yield is so small as to hardly justify the extra expense.

These experiments might be criticised on the grounds that the Rock Phosphate ground locally is not sufficiently finely divided to make it readily available to the plant. To test this point an experiment was started in which ground Rock Phosphate was tested against super-phosphate. Unfortunately, this experiment was a failure as the crop failed completely, but it will be repeated again this year.

A further experiment was also carried out to test whether F.Y.M. made with bedding is superior to native made manure, or to kraaling. The results of these experiments are given below.

Rate of Manuring Experiment—Guinea Corn.

(*See* Table No. 1.)

	Guinea corn heads in lb. per acre	Odds that difference is significant.
Average yield 30 control plots manured with 5 tons F.Y.M. per acre	1,933	—
Average difference 7 plots manured with 3 tons F.Y.M. per acre	−135 ± 164	4 : 1
Average difference 7 plots manured with 7 tons F.Y.M. per acre	+150 ± 164	5 : 1
Average difference 7 plots manured with 9 tons F.Y.M. per acre	+262 ± 164	17 : 1
Average difference 7 plots manured with 11 tons F.Y.M. per acre	+306 ± 164	34 : 1

Very good yields of guinea corn were obtained from this block, but there was considerable variation even among the standard plots. This was partly due to the uneven fertility of the block and partly to the fact that the manure applied, Kano town manure, varied greatly in quality. The first fourteen plots yielded a ton of corn per acre on head, but the remaining plots were not quite so good. The experiment was commenced last year, cotton being the crop. The results were not conclusive, but indicated that an increased yield would be obtained by applying up to at least five tons of manure per acre. The results this year are more definite and are a good example of the application of the "law of diminishing returns." Up to seven tons per acre the increased yield for each ton of manure applied becomes steadily greater but after this point is reached the return for each extra ton becomes steadily less.

Thus the increase from the application of 5 tons as compared with 3 tons								=135 lb.
„	„	„	7	„	„	5	„	=150 lb.
„	„	„	9	„	„	7	„	=112 lb.
„	„	„	11	„	„	9	„	= 44 lb.

From five to seven tons per acre would therefore appear to be the most economical dressing.

The experiment will be repeated again this season, but no manures will be applied in order to test the residual effect on the soil of the previous season's dressing.

Artificial Manure Experiment—Ground Nuts.

(*See* Table No. 2.)

	Undecorticated ground-nuts in lb. per acre.	Odds that the difference is significant.
Average yield 17 control plots with 3 tons F.Y.M. per acre	1,373	—
Average difference 4 plots with ground Nigerian rock phosphate 200 lb. per acre	−190 ± 93	43 : 1
Average difference 3 plots unmanured ...	−350 ± 108	1,448 : 1
Average difference 3 plots with ground Nigerian rock phosphate 200 lb. per acre + (NH_4) SO_4 75 lb. per acre ...	−100 ± 108	5 : 1
Average difference 3 plots with ground Nigerian rock phosphate 200 lb. per acre + K_2 O 60 lb. per acre	−259 ± 108	92 : 1
Average difference 3 plots with F.Y.M. 3 tons per acre ground Nigerian Rock phosphate 200 lb. per acre	−149 ± 108	11 : 1

The yield of groundnuts from this block was quite good throughout. As might have been expected the yield from the unmanured plots was inferior to that from the treatments, but the plots which received both potash and phosphate were only slightly better. Ammonium sulphate does not appear to be as effective as farm yard manure, probably due to the fact that being very soluble it is easily washed out of the soil, while the addition of phosphate to F.Y.M. caused no increase whatever. Such a result amply justifies our attempts to introduce mixed farming and the systematic making of F.Y.M.

Phosphate Experiment Cotton following Ground Nuts.

(*See* Table No. 3 (*a*).)

	Seed cotton lb. per acre.	Odds that difference is significant.
Average yield 13 control plots unmanured	177	—
Average difference 4 plots with N_2 (as dung)	+34 ± 30	7 : 1
Average difference 4 plots with P_2 O_5 (as ground Nigerian rock phosphate)	+14 ± 30	2 : 1
Average difference 4 plots with N_2 + P_2 O_5	+40 ± 30	10 : 1

The cotton on this block did not yield at all well. Possibly this was due to late planting as it was not planted till the end of June. As compared with the unmanured plots all the treatments caused a slight increase in yield, but in the case of phosphate alone this was almost negligible. The best results were obtained from those plots manured with a combination of phosphate and F.Y.M. but the experiment can hardly be regarded as conclusive as in neither case

was the difference sufficiently significant. This block was cropped with ground nuts last season and the results should be compared with those given in Table No. 3 (*b*) where the cotton follows mucuna.

Phosphate Experiment Cotton following Mucuna.

(*See* Table No. 3 (*b*).)

	Seed cotton lb. per acre.	Odds that difference is significant.
Average yield 13 control plots unmanured	188	—
Average difference 4 plots with N_2 (as dung)	+61 ± 28	43 : 1
Average difference 4 plots with $P_2 O_5$ (as ground Nigerian rock phosphate) ...	+87 ± 28	740 : 1
Average difference 4 plots with N_2 (as dung) + $P_2 O_5$	+75 ± 28	160 : 1

In this experiment the cotton followed mucuna instead of groundnuts as in the experiment described above, and the yield is slightly better.

In this case both phosphate alone, and a combination of phosphate and dung have given a better yield than dung alone. This is rather difficult to explain, but it may be due to the poor quality of the dung, which was made by the native method.

Treatment of Manure Experiment—Cotton.

(*See* Table No. 4.)

	Seed cotton lb. per acre.	Odds that difference is significant.
Average yield 9 control plots manured with native made manure at the rate of 300 cattle nights per acre	243	—
Average difference 4 plots kraaled at the rate of 300 cattle night per acre ...	−15 ± 20	4 : 1
Average difference 4 plots with F.Y.M. at the rate of 300 cattle nights per acre	−24 ± 20	8 : 1

All plots were manured at the same rate, namely the manure produced from 300 cattle nights. Last year F.Y.M. made with bedding gave the best result and it was anticipated that a similar result would be obtained this year, but as will be seen there is very little difference between the various treatments. This is probably due to the fact that the native made manure was of much better quality than that which is ordinarily produced in a native homestead. The actual manure used was not made until after the commencement of the dry season and suffered no loss from leaching, so that it differed very little from pen made manure whereas the manure made in a native compound is subjected to washing all through the rains and the stock receive little or no concentrated foodstuffs.

This experiment will be repeated again this season and care will be taken to ensure that the native made manure is genuinely typical of the manure actually used by the local farmers.

EXHAUSTIBILITY EXPERIMENT YEAR II, GERO (2).
(*See* TABLE No. 5 (*a*).)

	Yields of Gero heads lb. per acre.	Odds that difference is significant.
Average yield 13 control plots following mucuna	149	—
Average difference 4 plots following cotton	+77 ±34	81 : 1
Average difference 4 plots following guineacorn	+21±34	3 : 1
Average difference 4 plots following groundnuts	−46±34	11 : 1

This block was in extremely poor heart due to lack of manure and the crops gave very poor yields. The results indicate that ground nuts are a more exhausting crop than either cotton or guinea corn. At Zaria the reverse is found to be the case, ground nuts there being the least exhaustive of all the crops grown.

EXHAUSTIBILITY EXPERIMENT YEAR II, GUINEA CORN (FARAFARA).
(*See* TABLE No. 5 (*b*).)

	Guineacorn heads in lb. per acre.	Odds that difference is significant.
Average yield 13 control plots following mucuna	389	—
Average difference 4 plots following cotton	+ 1± 98	—
Average difference 4 plots following guineacorn	−218 ±98	71 : 1
Average difference 4 plots following groundnuts	−122 ± 98	8 : 1

The guinea corn grown here gave a very poor yield due, as mentioned in the previous experiment to lack of manure. The white seeded variety of guinea corn was sown (Hausa Farafara), and this variety never seems to do as well at Kano as the yellow variety (Hausa Kaura). Farafara needs a more fertile and moister soil than Kaura. As in the previous experiment cotton is shown to be the least exhaustive of the crops tested.

Exhaustibility Experiment Year II, Wake.
(*See* Table No. 5 (*c*).)

	Unthreshed cowpeas lb per acre.	Odds that difference is significant.
Average yield 13 control plots following mucuna	127	—
Average difference 4 plots following cotton	− 8±18	2 : 1
Average difference 4 plots following guineacorn	−38± 18	55 : 1
Average difference 4 plots following groundnuts	+10 ±18	2 : 1

The cowpeas were sown in two lines in each plot, and the yield was fairly satisfactory, but the results are of no great significance.

Cotton Selections Test. Allen Nos. 1, 5, 13.
(*See* Table No. 6.)

	Seed cotton lb. per acre.	Odd that difference is significant.
Average yield 17 control plots Allen 1	209	—
Average difference 8 plots with Allen 5	+18±13	11 : 1
Average difference 8 plots with Allen 13	−32±13	160 : 1

These results would have been better if sowing had been earlier. The seed was not sown till the beginning of July which is rather too late for this district. This block was used for experimenting with locally-made implements, and as these were at first in some respects unsuitable, a certain amount of damage was done to the plants. Allen No. 5 shows an increase over Allen No. 1, but the results are not sufficiently reliable to draw any definite conclusion.

Cost of Main Crops in Man Days per Acre.
(*See* Table No. 7.)

The costs in this table are comparatively low due undoubtedly to a large part of the farm being cultivated with bullocks. The costs under legumes would have been much higher, if more of the crop had warranted harvesting.

Cost of Production and Revenue from Main Crops.
1927-28 Season.
(*See* Table No. 8.)

Revenue is lower than last season owing to their being abundant crops grown and no fear of food shortage. The costs of production are low due to the reasons stated in Table No. 7.

Rainfall and Temperature.
(*See* Table No. 9.)

Monthly rainfall and temperature during the season under review and averages for the previous six years.

E. T. HOLMES,
Superintendent of Agriculture,
Kano.

TABLE No. 1.

Rate of Manuring Experiment.

No. of Plot.	Treatment.	Yield of guinea corn heads in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block K.			
1	At the rate of 5 tons per acre.	2,280	
2	" " 3 " "	2,308	+ 90
3	" " 5 " "	2,156	
4	" " 11 " "	2,944	+ 676
5	" " 5 " "	2,380	
6	" " 7 " "	2,224	− 160
7	" " 5 " "	2,388	
8	" " 9 " "	2,584	+ 154
9	" " 5 " "	2,472	
10	" " 3 " "	2,252	− 236
11	" " 5 " "	2,504	
12	" " 11 " "	2,500	− 50
13	" " 5 " "	2,596	
14	" " 7 " "	2,436	− 32
15	" " 5 " "	1,968	
16	" " 9 " "	1,932	+ 132
17	" " 5 " "	1,622	
18	" " 3 " "	1,720	− 60
19	" " 5 " "	1,828	
20	" " 11 " "	2,256	+ 338
21	" " 5 " "	2,008	
22	" " 7 " "	1,832	+ 54
23	" " 5 " "	1,548	
24	" " 9 " "	1,608	+ 28
25	" " 5 " "	1,612	
26	" " 3 " "	1,532	+ 50
27	" " 5 " "	1,352	
28	" " 11 " "	2,008	+ 204
29	" " 5 " "	2,256	
30	" " 7 " "	2,000	+ 102
31	" " 5 " "	1,540	
32	" " 9 " "	1,956	+ 252
33	" " 5 " "	1,848	
34	" " 3 " "	1,416	− 388
35	" " 5 " "	1,760	
36	" " 11 " "	1,832	− 266
37	" " 5 " "	2,436	
38	" " 7 " "	2,120	+ 132
39	" " 5 " "	1,540	
40	" " 9 " "	2,700	+ 824
41	" " 5 " "	2,212	
42	" " 5 " "	1,932	Non experimental
43	" " 5 " "	2,456	
44	" " 3 " "	1,940	− 238

TABLE No. 1—*continued.*

No. of Plot.	Treatment.	Yield of guinea corn heads in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
45	At the rate of 5 tons per acre.	1,900	
46	„ „ 11 „ „	2,016	+ 648
47	„ „ 5 „ „	1,836	
48	„ „ 7 „ „	2,764	+ 954
49	„ „ 5 „ „	1,784	
50	„ „ 9 „ „	2,192	+ 464
51	„ „ 5 „ „	1,672	
52	„ „ 3 „ „	1,940	− 164
53	„ 5 „ „	1,736	
54	„ „ 11 „ „	2,204	+ 586
55	„ „ 5 „ „	1,500	
56	„ „ 7 „ „	1,432	+ 2
57	„ „ 5 „ „	1,360	
58	„ „ 9 „ „	1,372	− 20
59	„ „ 5 „ „	1,424	

Each Plot ¼ acre. Ridges 3′ 6″. Sown May 23rd–24th, 1927. Harvested Nov. 21st–23rd, 1927.

Increase (+) or decrease (−) of 7 plots of 3 tons per acre compared with 5 tons per acre.

+ 90 lb. per acre.
− 236 „ „ „
− 60 „ „ „
+ 50 „ „ „
− 388 „ „ „
− 238 „ „ „
− 164 „ „ „

Average − 135 ± 164 lb. per acre.

Increase (+) or decrease (−) of 7 plots of 7 tons per acre compared with 5 tons per acre.

− 160 lb. per acre.
− 32 „ „ „
+ 54 „ „ „
+ 102 „ „ „
+ 132 „ „ „
+ 954 „ „ „
+ 2 „ „ „

Average + 150 ± 164 lb. per acre.

Increase (+) or decrease (−) of 7 plots of 9 tons per acre compared with 5 tons per acre.

+ 154 lb. per acre.
+ 132 „ „ „
+ 28 „ „ „
+ 252 „ „ „
+ 824 „ „ „
+ 464 „ „ „
− 20 „ „ „

Average + 262 ± 164 lb. per acre.

Increase (+) or decrease (−) of 7 plots of 11 tons per acre compared with 5 tons per acre.

+ 676 lb. per acre.
− 50 „ „ „
+ 338 „ „ „
+ 204 „ „ „
− 266 „ „ „
+ 648 „ „ „
+ 586 „ „ „

Average + 306 ± 164 lb. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 432·89.

Cost of cultivation in man-days per acre = 49·3.

TABLE No. 2.

Artificial Manure Experiment.

No. of Plot.		Treatment.	Yield of Groundnuts lb. per acre dry undecorticated.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block	I.			
43	1	F.Y.M. 3 tons per acre ...	1,512	
43	2	P_2O_5 200 lb. „ „ ...	1,344	− 108
44	1	F.Y.M. 3 tons „ „ ...	1,392	
44	2	Unmanured	1,112	− 292
45	1	F.Y.M. 3 tons per acre ...	1,416	
45	2	P_2O_5 200 lb. per acre + $(NH_4)_2SO_4$ 75 lb. per acre	1,456	+ 120
46	1	F.Y.M. 3 tons per acre ...	1,256	
46	2	P_2O_5 200 lb. per acre + K_2O 60 lb. per acre	1,160	− 244
47	1	F.Y.M. 3 tons per acre ...	1,552	
47	2	F.Y.M. 3 tons per acre + P_2O_5 200 lb. per acre	1,360	− 64
48	1	F.Y.M. 3 tons per acre ...	1,296	
48	2	P_2O_5 200 lb. „ „ ...	1,016	− 256
49	1	F.Y.M. 3 tons „ „ ...	1,248	
49	2	Unmanured	872	− 400
50	1	F.Y.M. 3 tons per acre ...	1,296	
50	2	P_2O_5 200 lb. per acre + $(NH_4)_2SO_4$ 75 lb. per acre ...	1,056	− 384
51	1	F.Y.M. 3 tons per acre ...	1,584	
51	2	P_2O_5 200 lb. per acre + K_2O 60 lb. per acre	1,288	− 228
52	1	F.Y.M. 3 tons per acre ...	1,448	
52	2	F.Y.M. 3 tons per acre + P_2O_5 200 lb. per acre	1,120	− 340
53	1	F.Y.M. 3 tons per acre ...	1,480	
53	2	P_2O_5 200 lb. „ „ ...	1,136	− 180
54	1	F.Y.M. 3 tons „ „ ...	1,152	
54	2	Unmanured	952	− 360
55	1	F.Y.M. 3 tons per acre ...	1,472	
55	2	P_2O_5 200 lb. per acre + $(NH_4)_2SO_4$ 75 lb. per acre ...	1,384	− 36
56	1	F.Y.M. 3 tons per acre ...	1,368	
56	2	P_2O_5 200 lb. per acre + K_2O 60 lb. per acre	1,032	− 304
57	1	F.Y.M. 3 tons per acre ...	1,304	
57	2	F.Y.M. 3 tons per acre + P_2O_5 200 lb. per acre	1,264	− 44
58	1	F.Y.M. 3 tons per acre ...	1,312	
58	2	P_2O_5 200 lb. „ „ ...	1,184	− 216
59	1	F.Y.M. 3 tons „ „ ...	1,488	
59	2	F.Y.M. 3 „ „ „ ...	1,320	Non experimental.

TABLE No 2.—*continued.*

Each plot $\frac{1}{8}$ acre. Ridges 3' 6". Sown 22nd June, 1927. Harvested 26th November, 1927.

Increase (+) or decrease (−) of 4 plots with P_2O_5 200 lb. per acre compared with F.Y.M. 3 = tons per acre.	Increase (+) or decrease (−) of 3 plots unm anured compared with F.Y.M. 3 tons per acre.	Increase (+) or decrease (−) of 3 plots with P_2O_5 200 per acre + $(NH_4)_2SO_4$ 75 lb. per acre compared with F.Y.M. = tons per acre.
− 108 lb. per acre.	− 292 lb. per acre.	+ 120 lb per acre.
− 256 „ „	− 400 „ „	− 384 „ „
− 180 „ „	− 360 „ „	− 36 „ „
− 216 „ „	—	—
Average − 190 ± 93 lb. per acre.	Average − 350 ± 108 lb. per acre.	Average − 100 ± 108 lb. per acre

Increase (+) or decrease (−) of 3 plots with P_2O_5 200 lb. per acre + K_2O 60 lb. per acre compared with F.Y.M. 3 tons per acre.	Increase (+) or decrease (−) of 3 plots with F.Y.M. 3 tons per acre + P_2O_5 200 lb. per acre compared with F.Y.M. 3 tons per acre.
− 244 lb. per acre.	− 64 lb. per acre.
− 228 „ „ „	− 340 „ „ „
− 304 „ „	− 44 „ „ „
Average − 259 ± 108 lb. per acre.	Average − 149 ± 108 lb. per acre.

Root — mean— square — difference between pairs of neighbouring controls = 186·5.

Cost of Cultivation in man days per acre = 72·1.

TABLE No. 3 (*a*).

PHOSPHATE EXPERIMENT COTTON FOLLOWING GROUNDNUTS.

No. of Plot.	Treatment.	Yield of Seed cotton lb. per acre.	Increase (+) or Decrease (−) compared with mean of adjacent controls.
Block E.			
1	Unmanured	140	
2	N_2	240	+ 80
3	Unmanured	180	
4	P_2O_5	215	+ 5
5	Unmanured	240	
6	$N_2 + P_2O_5$	290	+ 93
7	Unmanured	155	
8	N_2	250	+ 80
9	Unmanured	185	
10	P_2O_5	165	− 15
11	Unmanured	175	
12	$N_2 + P_2O_5$	210	+ 55
13	Unmanured	135	
14	N_2	165	− 25
15	Unmanured	245	
16	P_2O_5	230	+ 15
17	Unmanured	185	
18	$N_2 + P_2O_5$	185	+ 3
19	Unmanured	180	
20	N_2	205	+ 8
21	Unmanured	215	
22	P_2O_5	220	+ 53
23	Unmanured	120	
24	$N_2 + P_2O_5$	145	+ 8
25	Unmanured	155	

Each plot $\frac{1}{20}$ acre. Ridges 3'. Sown 8th July, 1927. Harvested 22nd November, 1927. 1st December, 1927. 12th December, 1927.

Increase (+) or decrease (−) of 4 plots with N_2 compared with unmanured.	Increase (+) or decrease (−) of 4 plots with P_2O_5 compared with unmanured.	Increase (+) or decrease (−) of 4 plots with $N_2 + P_2O_5$ compared with unmanured.
+ 80	+ 5	+ 93
+ 80	− 15	+ 55
− 25	+ 15	+ 3
+ 8	+ 53	+ 8

Average + 34 ± 30 lb. per acre. Average + 14 ± 30 lb. per acre. Average + 40 ± 30 lb. per acre.

Root–mean–square–difference between pairs of neighbouring controls = 60·69.

Cost of cultivation in man days per acre = 28.

TABLE No. 3 (*b*).

Phosphate Experiment Cotton following Mucuna.

No. of Plot.	Treatment.	Yield of Seed cotton lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block E.			
1	Unmanured	80	
2	N_2	235	+ 100
3	Unmanured	190	
4	P_2O_5	275	+ 88
5	Unmanured	185	
6	$N_2 + P_2O_5$	305	+ 125
7	Unmanured	175	
8	N_2	275	+ 60
9	Unmanured	255	
10	P_2O_5	260	+ 50
11	Unmanured	165	
12	$N_2 + P_2O_5$	280	+ 115
13	Unmanured	165	
14	N_2	260	+ 75
15	Unmanured	205	
16	P_2O_5	275	+ 48
17	Unmanured	250	
18	$N_2 + P_2O_5$	215	− 37
19	Unmanured	255	
20	N_2	240	+ 10
21	Unmanured	205	
22	P_2O_5	335	+ 163
23	Unmanured	140	
24	$N_2 + P_2O_5$	255	+ 98
25	Unmanured	175	

Each plot $\frac{1}{20}$ acre. Ridges 3'. Sown 8th July, 1927. Harvested { 22nd November, 1927. 1st December, 1927. 12th December, 1927.

Increase (+) or decrease (−) of 4 plots with N_2 compared with unmanured.	Increase (+) or decrease (−) of 4 plots with P_2O_5 compared with unmanured.	Increase (+) or decrease (−) of 4 plots with $N_2 + P_2O_5$ compared with unmanured.
+ 100	+ 88	+ 125
+ 60	+ 50	+ 115
+ 75	+ 48	− 37
+ 10	+ 163	+ 98
Average + 61 ± 28 lb. per acre.	Average + 87 ± 28 lb. per acre.	Average + 75 ± 28 lb. per acre.

Root—mean—square—difference—between pairs of neighbouring controls plots = 56·64

Cost of cultivation in man days per acre = 28.

TABLE No. 4.

Treatment of Manure Experiment.

No. of Plot.	Treatment.	Yield of Seed cotton in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block B. 1 —17			
1	Native Method	216	
2	Kraaled	234	− 10
3	Native Method	273	
4	F. Y. M.	223	− 36
5	Native Method	245	
6	Kraaled	225	− 29
7	Native Method	264	
8	F. Y. M.	222	− 38
9	Native Method	257	
10	Kraaled	239	− 10
11	Native Method	242	
12	F. Y. M.	232	+ 2
13	Native Method	218	
14	Kraaled	205	− 10
15	Native Method	212	
16	F. Y. M.	211	− 25
17	Native Method	261	

Each plot ¼ acre. Ridges 3'. Sown 23rd June, 1927. Harvested { 30th November, 1927. 9th December, 1927. 19th December, 1927.

Increase (+) or decrease (−) of 4 plots kraaled compared with native method.	Increase (+) or decrease (−) of 4 plots F. Y. M. compared with native method.
− 10	− 36
− 29	− 38
− 10	+ 2
− 10	− 25
Average − 15 ± 20 lb. per acre	Average − 24 ± 20 lb. per acre.

Root−mean−square−difference between pairs of neighbouring controls plots =40.

Cost of cultivation in man days per acre = 51·1.

TABLE No. 5 (*a.*)

Exhaustibility Experiment Year II Gero (2).

No. of Plot.	Previous Crop.	Yield of Gero heads in lb per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block A.1–25			
1	After Mucuna	86	
2	,, Cotton ...	200	+ 108
3	,, Mucuna	98	
4	,, Guineacorn ...	193	+ 82
5	,, Mucuna	125	
6	,, Groundnuts ...	190	+ 7
7	,, Mucuna.. ...	242	
8	,, C otton ...	339	+ 55
9	,, Mucuna	326	
10	,, Guineacorn ...	250	− 34
11	,, Mucuna	242	
12	,, Groundnuts ..	119	− 75
13	,, Mucuna	146	
14	,, Cotton ...	280	+ 149
15	,, Mucuna	116	
16	,, Guineacorn ...	187	+ 52
17	,, Mucuna	154	
18	,, Groundnuts ...	38	− 93
19	,, Mucuna	108	
20	,, Cotton ...	130	− 2
21	,, Mucuna	156	
22	,, Guineacorn ...	90	− 15
23	,, Mucuna	54	
24	,, Groundnuts ...	45	− 24
25	,, Mucuna	84	

Each plot ¼ acre. Ridges 3′ 6″. Sown 8 May, 1927. Harvested 2nd November, 1927.

Increase (+) or decrease (−) of 4 plots of Gero (2) following groundnuts.	Increase (+) or decrease (−) of 4 plots of Gero (2) following guineacorn.	Increase (+) or decrease (−) of 4 plots of Gero (2) following groundnuts.
+ 108	+ 82	+ 7
− 55	− 34	− 75
+ 149	− 52	− 93
− 2	− 15	− 24
Average + 77 ± 34 lb per acre	Average +21 ± 34 lb per acre.	Average − 46 ± 34 lb per acre.

Root—mean—square—difference between pairs of neighbouring controls = 68·2.

Cost of cultivation in man-days per acre = 9·4.

TABLE No 5 (*b*).

Exhaustibility Experiment Year II Guineacorn.

No. of Plot.	Previous Crop.	Yield of Guineacorn heads in lb per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block A. 1-25			
1	After Mucuna	612	
2	,, Cotton ...	532	+ 68
3	,, Mucuna	316	
4	,, Guineacorn ...	148	− 224
5	,, Mucuna	428	
6	,, Groundnuts ...	588	− 44
7	,, Mucuna	736	
8	,, Cotton ...	556	− 176
9	,, Mucuna	732	
10	,, Guineacorn ...	132	− 410
11	,, Mucuna	352	
12	,, Groundnuts ...	128	− 198
13	,, Mucuna	300	
14	,, Cotton ...	488	+ 174
15	,, Mucuna	328	
16	,, Guineacorn ...	228	− 186
17	,, Mucuna	500	
18	,, Groundnuts ...	188	− 180
19	,, Mucuna	236	
20	,, Cotton ...	196	− 60
21	,, Mucuna	276	
22	,, Guineacorn ...	168	− 54
23	,, Mucuna	168	
24	,, Groundnuts ...	56	− 68
25	,, Mucuna	80	

Each plot ¼ acre. Ridges 3′ 6″. Sown 25th May, 1927. Harvested 24th November, 1927

Increase (+) or decrease (−) of 4 plots of guineacorn following cotton.	Increase (+) or decrease (−) of 4 plots of guineacorn following guineacorn.	Increase (+) or decrease (−) of 4 plots of guineacorn following groundnuts.
+ 68	− 224	− 44
− 178	− 410	− 198
+ 174	− 186	− 180
− 60	− 54	− 68
Average + 1 ± 98 lb per acre.	Average − 218 ± 98 lb per acre	Average − 122 ± 98 lb per acre.

Root—mean—square—difference between pairs of neighbouring controls = 196·8.

Cost of cultivation in man-days per acre = 23·7.

TABLE No. 5 (*c*).

Exhaustibility Experiment Year II Wake.

No. of Plots.	Previous Crop.	Yield of unthreshed Wake in lb per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block A. 1-25			
1	After Mucuna	112	
2	,, Cotton ...	116	− 10
3	,, Mucuna	140	
4	,, Guineacorn ...	208	+ 72
5	,, Mucuna	132	
6	,, Groundnuts ...	96	− 24
7	,, Mucuna	108	
8	,, Cotton ...	140	+ 56
9	,, Mucuna	60	
10	,, Guineacorn ...	136	+ 42
11	,, Mucuna	128	
12	,, Groundnuts ...	160	+ 6
13	,, Mucuna	180	
14	,, Cotton ...	124	− 42
15	,, Mucuna	152	
16	,, Guineacorn ...	96	− 30
17	,, Mucuna	100	
18	,, Groundnuts ...	172	+ 64
19	,, Mucuna	116	
20	,, Cotton ...	92	− 36
21	,, Mucuna	140	
22	,, Guineacorn ...	204	+ 70
23	,, Mucuna	128	
24	,, Groundnuts ...	136	− 4
25	,, Mucuna	152	

Each plot $\frac{1}{4}$ acre. Ridges 3′ 6″. Sown 14th July, 1927. Harvested 24th November, 1927

Increase (+) or decrease (−) of 4 plots of wake following cotton.	Increase (+) or decrease (+) of 4 plots of wake following guineacorn.	Increase (+) or decrease (−) of 4 plots of wake following groundnuts.
− 10	+ 72	− 24
+ 56	+ 42	+ 6
− 42	− 30	+ 64
− 36	+ 70	− 4
Average -8 ± 18 lb per acre.	Average $+38 \pm 18$ lb per acre.	Average $+10 \pm 18$ lb per acre.

Root—mean—square—difference between pairs of neighbouring control plots = 35·8.

Cost of cultivation in man-days per acre = 4·7.

TABLE No. 6.

Cotton Variety Test.

No of Plot.	Variety.	Yield of seed cotton in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block N.			
26–59			
26	Allen 1 Standard	111	
27	„ 5	169	+ 38
28	„ 1 „	152	
29	„ 13	119	− 22
30	„ 1 „	140	
31	„ 5	194	+ 50
32	„ 1 „	149	
33	„ 13	119	− 13
34	„ 1 „	115	
35	„ 5	129	− 8
36	„ 1 „	160	
37	„ 13	162	− 33
38	„ 1 „	230	
39	„ 5	235	− 13
40	„ 1 „	266	
41	„ 13	240	− 5
42	„ 1 „	224	
43	„ 5	267	+ 9
44	„ 1 „	292	
45	„ 13	131	− 138
46	„ 1 „	246	
47	„ 5	260	+ 10
48	„ 1 „	254	
49	„ 13	217	− 39
50	„ 1 „	258	
51	„ 5	258	+ 20
52	„ 1 „	219	
53	„ 13	216	− 2
54	„ 1 „	218	
55	„ 5	242	+ 37
56	„ 1 „	192	
57	„ 13	176	− 1
58	„ 1 „	162	
59	„ 1	non experimental	

Each plot ¼ acre. Ridges 3′ 6″. Sown 1st July, 1927. Harvested 21st November, 1st December and 17th December, 1927.

Increase (+) or decrease (−) of 8 plots of Allen 5 compared with Allen 1.	Increase (+) or decrease (−) of 8 plots of Allen 13 compared with Allen 1.
+ 38	− 22
+ 50	− 13
− 8	− 33
− 13	− 5
+ 9	− 138
+ 10	− 39
+ 20	− 2
+ 37	− 1
Average + 18 ± 13 lb. per acre.	Average − 32 ± 13 lb. per acre.

Root—mean—square—difference between pairs of neighbouring control plots = 38.

Cost of cultivation in man-days per acre = 55·1

TABLE No. 7.

Cost of Main Crops in Man Days per Acre.

Crop.	Preparation.	Planting.	Cultivation.	Harvest.	Store Work.	Total N.D.P.A.
Cotton	11·1	4·8	18·4	18·7	2·8	55·8
Guineacorn	1·5	3·2	17·2	12·2	--	34·1
Groundnuts	8·0	2·9	18·2	38·6	10·8	78·5
Gero	—	·9	4·1	·8	—	5·8
Legumes Single Crop	·3	4·4	9·3	3·0	—	17·0
Legumes Interplanted	·4	·6	1·3	1·3	—	3·6

TABLE No. 8.

Comparison of Cost of Production and Revenue from Main Crops.—1927–28 Season.

Crop.	Cost in Man Days.	Average yield per acre in lb.	Cost of crop in Man Days per lb.	Assumed market value per lb.	Calculated return per acre (including transport to market).	Monetary return per Man Day.	Nature of Crop.
					£ s. d.		
Cotton ...	55·8	255	0·22	2d.	2 1 10	8·9d.	Seed Cotton.
Guineacorn	34·1	929	—	0·6d.	2 0 7	14·3d.	Unthreshed.
Gero ...	5·8	208	—	0·6d.	0 9 0	18·6d.	Unthreshed.
Groundnuts	78·5	1,410	0·05	1·4d.	7 10 6	23·0d.	Decorticated.

TABLE No. 9.

Monthly Rainfall and Mean Temperature.

Month.	Rainfall in inches, Plantation.	Rainfall in inches, Survey School.	Average fall over 6 years. Survey School.	Mean Temperature.	Mean Temperature over 6 years.
January ...	Nil	Nil	Nil	69·9	69·6
February ...	,,	,,	,,	75·9	75·4
March ...	,,	,,	0·14	80·7	82·9
April ...	0·64	0·04	0·21	88·7	89·0
May	3·43	2·06	1·30	89·3	88·7
June	6·62	4·35	4·23	83·7	84·3
July	8·22	6·27	7·12	80·0	79·8
August ..	12·44	11·77	11·63	79·4	78·3
September ...	7·84	5·79	5·83	80·4	80·4
October ...	0·07	0·04	0·63	83·6	81·1
November ...	...	...	...	79·0	74·5
December ...	...	..	...	77·1	72·4
Total ...	39·26	30·32	30·95	80·6	79·4

ANNUAL REPORT—SOKOTO IRRIGATION FARM, 1927.

BY

J. D. Brown, B.Sc.

The Kworre Irrigation Farm, which originated in February 1926, lies along the western flank of the Rima river valley and close to the junction of the latter with the Shalla brook. This stream being perennial, supplies through the medium of canals and distributaries, the water necessary to irrigate the Government farm and a considerable area of land in its vicinity.

Those rice farmers, however, outside the radius of canal water, depend for the maturity of their rain germinated crop, on the annual overflowing of its bank by the Rima river and subsequent inundation by flood water of the surrounding alluvial plain.

In the meantime the Government farm is directly affected by this flood water, a factor which will continue to dictate the general lines of all cropping schemes until eventually controlled. In the absence of complete control of this flood water, cropping has been conducted along the following lines:—

(*a*) By utilising canal water " dates of sowing " experiments have been carried out in attempting to prove that under local conditions as elsewhere, the crop with the longer growing period will return the heavier yield. While it cannot be claimed that the above has been finally and definitely verified it is markedly indicated that further experiment is more than justified, as it was found that the best yields were in many cases obtained from plots sown considerably earlier than is customary among the local people.

The results of these " dates of sowing " experiments are given below, and they all suggest that the period between 17th and 24th May (*i.e.*, the earlier plantings) was the best time for planting under the conditions prevailing at Kworre in 1927. This is particularly marked with the exotic varieties guiana creole and maliya, but the results with native varieties are less significant. This is probably due to the fact that both guiana creole and maliya are more pure than the local varieties which are very mixed indeed, in some cases being less than fifty *per cent.* pure, so that with a mixed population of this degree definite or constant results could hardly be anticipated.

Although planting was done on various dates with each variety, in each case all plots were ready for harvesting at the same time, the only exception being the local early variety Biyan. It would appear therefore that the latter has a definite growing period and will only ripen at the end of that period, but the fact that the others all ripened within a short time of each other irrespective of the date of planting was probably due to the earlier waterings not being properly carried out. The experiments are being repeated this year and as we have now had more experience with the management of the water the results will probably differ from those obtained this year.

(*b*) The securing of a dry season crop off rice land is also important. This has already been achieved with such crops as wheat, onions, maize and sweet potatoes, following rice but less success has attended the cultivation of guinea corn, millet and cotton. Amongst the various factors which militate against successful dry weather cultivation of these crops are :—

(1) Low temperature of air and soil at planting.
(2) Attacks of insects and birds.
(3) Permanent high water table.

(*c*) Research into the conduct of flood water and observations of seepage water is being conducted in co-operation with the Irrigation Engineer.

(*d*) As adjuncts to the main scheme, experiments were incorporated to test the relative advantages of transplanted rice and broadcasted rice; and of irrigated rice and rice planted and left to nature.

Rice Varieties.

The following are the exotic varieties of rice tested this year. The others mentioned are native :—

Guiana Creole. Maliya. Guiana seventy-five.

The season under review was an exceptionally good one for rice and high land cereals. The rainfall was a few inches higher than usual and although excessively high floods caused damage in a few places it is generally agreed that the 1927 rice crop was the heaviest gathered for many years.

The breaking of the Marabawa bank in September, however, and subsequent flooding of the Government farm must be held responsible for the tendency towards the low rice yields obtained on the farm. This tendency is, of course, to all intents and purposes uniform and hence should not interfere with interpretation of results.

It is confidently anticipated that many of the experiments only partially proved this year will be definitely verified next season, and results of considerable importance regarding the problems connected with irrigation in Nigeria may be anticipated.

Rice Variety Test.

(*See* Table No. 2.)

	Hulled Rice lb. per acre.	Odds that difference is significant.
Average yield, 13 plots Farin Iri ...	653 lb.	—
,, difference, 4 plots Bakin Iri ...	+ 47·5±101	2 : 1
,, ,, 4 ,, Jatau ...	+115·2±101	7 : 1
,, ,, 4 ,, G. Creole ...	+451·5±101	100·000 : 1

The marked superiority of the exotic over the native varieties, while confirming results obtained both at Samaru and Ilorin, is possibly largely due to the fact that guiana creole does not shed its ripe grains to any extent compared with all the native varieties. The hulling percentages of the above varieties were as follows:—

Guiana creole	67. 5 *per cent.*
Bakin iri	66.25 ,, ,,
Jatau	63.75 ,, ,,
Farin iri	61.25 ,, ,,

Farin iri was the lightest straw producer with bakin iri the heaviest—the difference being approximately 100 sheaves per acre.

The difference between the three local varieties is not very marked, doubtless due to the mixed nature of the seed—a characteristic which while reducing reliability of results also explains their uniformity.

The Botanist is now isolating pure strains of all the local varieties and when these are available more satisfactory results should be forthcoming.

Rice—Date of Planting Experiment.

(*See* Table No. 3.)

Variety—Maliya.

	Unhusked Rice lb. per acre.	Odds that difference is significant
Average yield, 17 plots sown 31st May ...	1,315 lb.	—
,, difference, 4 plots sown 17th May	+400±244	17 : 1
,, [illegible] ,, 4 ,, ,, 20th ,,	+365±244	17 : 1
,, [illegible] ,, 4 ,, ,, 7th June	−220±244	5 : 1
,, [illegible] ,, 4 ,, ,, 14th ,,	−204±244	5 : 1

Maliya is a red rice which was originally introduced from Ceylon. It was found at Ilorin to be a heavy yielder but with a marked tendency to shedding. It grows more strongly and is a bigger plant than guiana creole, in fact in appearance it is similar to many of the local varieties.

This is an interesting result, but one cannot accept that a difference of a week in sowing will produce such a discrepancy in yield as quoted above. Possibly some unobserved error has not been allowed for.

RICE—DATE OF PLANTING EXPERIMENT.

(*See* TABLE No. 4.)

Variety—Farin Iri.

	Unhusked Rice lb. per acre.	Odds that difference is significant.
Average yield, 17 plots sown May 31st ...	609 lb.	—
„ difference, 4 plots sown 17th May	+102 ± 170	3 : 1
„ „ 4 „ „ 24th „	+ 78 ± 170	2 : 1
„ „ 4 „ „ 6th June	−141 ± 170	4 : 1
„ „ 3 „ „ 14th „	+ 66 ± 197	Nil.

Farin iri is the commonest variety of rice in the Rima valley. This is due to the fact that its water requirement is very elastic and it is better able to adapt itself to its surroundings than other varieties. The grain, owing to its white colour, is popular in the local markets.

In the above experiment the odds that the earliest sown plots were better than the later are not enough to be definite. The eye could detect no difference between the early and the late sown plots.

RICE—DATE OF PLANTING EXPERIMENT.

(*See* TABLE No. 6.)

Variety—Biyau.

	Unhusked Rice lb. per acre.	Odds that difference is significant.
Average yield, 17 plots sown 13th May ...	386	—
„ difference, 4 plots sown 24th May	−128 ± 97	10 : 1
„ „ 4 „ „ 6th June	−264 ± 97	81 : 1
„ „ 4 „ „ 15th „	−177 ± 97	24 : 1
„ „ 4 „ „ 26th „	−270 ± 97	81 : 1

Biyau is the earliest of all the varieties tested here. The earliest sown plots were harvested on September 14th so that the period from planting to harvesting only occupied four months.

The best yield was obtained from the plots sown on May 13th, which also had a fifty *per cent.* higher straw yield and as this was the earliest date tested it is possible that it would have done even better if a still earlier date had been chosen, a supposition that will be tested next season. Biyau is not a high yielding variety, as might be expected from a variety with such a short growing period but

maturing as it does between the harvest of millet and guinea corn at a time when food is apt to be scarce it never fails to command a higher price.

RICE—DATE OF PLANTING EXPERIMENT.

(*See* TABLE No. 8.)

Variety—Guiana Creole.

	Unhusked Rice lb. per acre.	Odds that difference is significant.
Average yield, 13 plots sown 31st May ...	402 lb.	—
„ difference, 4 plots sown 17th May	+368 ± 102	4,350 : 1
„ „ 4 „ „ 24th „	+180 ± 102	24 : 1
„ „ 4 „ „ 7th June	−222 ± 120	55 : 1

It should be noted that this very definite result occurs with an exotic variety.

The number of sheaves from each sowing although only a rough guide also favours the early sowings.

These are :—

Standard averaged 448 sheaves per acre.
17.5.27, „ 544 „ „ „
24.5.27, „ 512 „ „ „
7.6.27, „ 288 „ „ „

As mentioned elsewhere guiana creole has the advantage over most of the other varieties that are being tested at Kworre, of being a light " shedder."

A point worth observing is that the three exotic varieties require a longer growing period than the local varieties.

RICE EXPERIMENT.

BROADCAST ON FLAT, DIBBLED ON RIDGE.

v.

TRANSPLANTING TO RIDGE.

(*See* TABLE No. 9.)

Variety—Guiana Creole.

	Unhusked Rice lb. per acre.	Odds that difference is significant.
Average yield, 9 plots Broadcast	661 lb.	—
Average difference, 4 plots dibbled on Ridge	−321 ± 214	14 : 1
Average difference, 4 plots transplanted to Ridge	+154 ± 214	4 : 1

It should be noted that although the comparative result of transplanting shows only low odds in its favour yet as far as the eye could tell the transplanted plots were very much superior to the others in straw grain and freedom from weeds. Possibly next year's result will be more definite.

J. DONALD BROWN,
Superintendent of Agriculture.

TABLE No. 1.

Monthly Rainfall at Kworre in 1926 and 1927.

	1926.	1927.
March	—	—
April	1·17	0·09
May	2·43	2·17
June	5·35	0·98
July	4·21	9·00
August	3·84	9·82
September	1·39	3·40
October	—	1·46
	18·39	26·92

TABLE No. 2.

RICE—VARIETY TEST.

Block Plots.	Variety.	Yield—lb. per acre. (Hulled Rice).	Increase (+) or decrease (−) compared with mean of adjacent controls.
A 1	Farin Iri	950	
2	Bakin Iri	992	− 2
3	Farin Iri	1,039	
4	Jatau	1,202	+ 183
6	Farin Iri	999	
7	Guiana Creole	1,715	+ 933
8	Farin Iri	566	
9	Bakin Iri	430	− 16
10	Farin Iri	326	
11	Jatau	693	+ 171
12	Farin Iri	718	
13	Guiana Creole	1,436	+ 729
14	Farin Iri	697	
22	Bakin Iri	871	+ 167
23	Farin Iri	712	
24	Jatau	647	+ 38
25	Farin Iri	506	
26	Guiana Creole	554	+ 104
27	Farin Iri	395	
28	Bakin Iri	517	+ 41
29	Farin Iri	557	
30	Jatau	624	+ 69
31	Farin Iri	553	
32	Guiana Creole	554	+ 40
33	Farin Iri	475	

Size of plots $\frac{1}{4}$ acre = Rate of Seeding — 100 lb. per acre.

Date of Sowing 20th May.

Date of Harvest, 25th October to 5th November.

TABLE No. 2—*continued.*

Increase (+) or decrease (−) of plots sown to Bakin Iri compared with plots sown to Farin Iri.	Increase (+) or decrease (−) of plots sown to Jatau compared with plots sown to Farin Iri.
− 2	+ 183
− 16	+ 171
+ 167	+ 38
+ 41	+ 69
Average + 47·5 ± 101 lb. per acre.	Average + 115·2 ± 101 lb. per acre.

Increase + or decrease − of plots sown to Guiana Creole compared with plots sown to Farin Iri.

+ 933
+ 729
+ 104
+ 40

Average + 451·5 ± 101 lb. per acre.

Root—mean—square—203·5 lb. per acre.

Cost of Cultivation in man-days per acre 300.

TABLE No. 3.

Rice—Date of Planting Experiment.

Variety—Maliya.

Block	Plots.	Date of Sowing.	Yields lb. per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.	
B1	1*a*	May 31	1,456			
	1*b*	May 17		1,472		− 384
	2*a*	May 31	2,256			
	2*b*	May 24		2,768	+ 648	
	3*a*	May 31	1,984			
	3*b*	June 7		1,744		− 136
	4*a*	May 31	1,776			
	4*b*	June 14		1,104		− 624
	5*a*	May 31	1,680			
	6*a*	May 17		752		− 528
	6*b*	May 31	880			
	7*a*	May 24		928	+ 352	
	7*b*	May 31	272			
	8*a*	June 7		112		− 160
	8*b*	May 31	272			
	9*a*	June 14		240		− 112
	9*b*	May 31	432			
	10*a*	May 17		704		− 192
	10*b*	May 31	1,360			
	11*a*	May 24		1,648	+ 168	
	11*b*	May 31	1,600			
	12*a*	June 7		1,040		− 536
	12*b*	May 31	1,552			
	13*a*	June 14		1,312		− 352
	13*b*	May 31	1,776			
	14*a*	May 17		1,312		− 496
	14*b*	May 31	1,840			
	15*a*	May 24		1,664	+ 292	
	15*b*	May 31	896			
	16*a*	June 7		1,040		− 48
	16*b*	May 31	1,280			
	17*a*	June 14		1,440	+ 272	
	17*b*	May 31	1,056			

TABLE No. 3—*continued.*

Size of plots = $\frac{1}{16}$ acre. Rate of A seeding = 100 lb. per acre.

Date of harvest 10th November.

Increase (+) or decrease (−) of Plots sown May 17th compared with plots sown May 31st.	Increase (+) or decrease (−) of Plots sown May 24th compared with plots sown May 31st.
− 384 lb. per acre.	+ 648 lb. per acre.
− 528 „ „ „	+ 352 „ „ „
− 192 „ „ „	+ 168 „ „ „
− 496 „ „ „	+ 292 „ „ „
Average − 400 ± 244 lb. per acre.	Average + 365 ± 244 lb. per acre.

Increase (+) or decrease (−) of Plots sown June 7th compared with plots sown May 31st.	Increase (+) or decrease (−) of Plots sown June 14th compared with plots sown May 31st.
− 136 lb. per acre.	− 624 lb. per acre.
− 160 „ „ „	− 112 „ „ „
− 536 „ „ „	− 352 „ „ „
− 48 „ „ „	+ 272 „ „ „
Average − 220 ± 244 lb. per acre.	Average − 204 ± 244 lb. per acre.

Root—mean—square—difference between pairs of adjacent controls = 488·3

Cost of cultivation in man-days per acre = 330.

TABLE No. 4.

RICE—DATE OF PLANTING EXPERIMENT.

Variety—Farin Iri.

Block	Plots.	Date of Sowing.	Yields lb. per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.	
C1	1*a*	May 31	1,088			
	1*b*	May 17		608		− 216
	2*a*	May 31	560			
	2*b*	May 24		592		− 32
	3*a*	May 31	688			
	3*b*	June 7		372		− 388
	4*a*	May 31	832			
	4*b*	June 14		—	—	—
	5*a*	May 31	576			
	5*b*					
	6*a*	May 17		1,392	+ 936	
	6*b*	May 31	336			
	7*a*	May 24		496	—	—
	7*b*	May 31	656			
	8*a*	June 7		608		− 192
	8*b*	May 31	944			
	9*a*	June 14		608	+ 16	
	9*b*	May 31	240			
	10*a*	May 17		176	—	—
	10*b*	May 31	112			
	11*a*	May 24		480	+ 272	
	11*b*	May 31	304			
	12*a*	June 7		240		− 120
	12*b*	May 31	415			
	13*a*	June 14		496	+ 32	
	13*b*	May 31	512			
	14*a*	May 17		128		− 312
	14*b*	May 31	368			
	15*a*	May 24		560	+ 72	
	15*b*	May 31	608			
	16*a*	June 7		1,072	+ 136	
	16*b*	May 31	1,264			
	17*a*	June 14		1,216	+ 152	
	17*b*	May 31	864			

TABLE No. 4—*continued.*

Size of plots $\frac{1}{16}$ acre. Rate of seeding 100 lb. per acre.

Date of harvest 2nd November.

Increase (+) or decrease (−) of Plots sown May 17th compared with plots sown May 31st.

− 216	lb. per acre.
+ 936	„ „ „
± 0	„ „ „
− 312	„ „ „

Average + 102 ± 170 lb. per acre.

Increase (+) or decrease (−) of Plots sown May 24th compared with plots sown May 31st.

− 32	lb. per acre.
± 0	„ „ „
+ 272	„ „ „
+ 72	„ „ „

Average + 78 ± 170 lb. per acre.

Increase (+) or decrease (−) of Plots sown June 7th compared with plots sown May 31st.

− 388	lb. per acre.
− 192	„ „ „
− 120	„ „ „
+ 136	„ „ „

Average − 141 ± 170 lb. per acre.

Increase (+) or decrease (−) of Plots sown June 14th compared with plots sown May 31st.

+ 16	lb. per acre.
+ 32	„ „ „
+ 152	„ „ „

Average + 66 ± 197 lb. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 341·3 lb. per acre.

Cost of cultivation in man-days per acre = 390.

TABLE No. 6.

Rice—Date of Planting Experiment.

Variety—Biyau.

Block	Plots.	Date of sowing.	Yield lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
C II	6*a*	May 13	208	
	6*b*	May 24	384	+ 152
	7*a*	May 13	256	
	7*b*	June 4	384	− 64
	8*a*	May 13	640	
	8*b*	June 15	736	+ 232
	9*a*	May 13	368	
	9*b*	June 26	128	− 136
	10*a*	May 13	160	
	10*b*	May 24	32	− 104
	11*a*	May 13	112	
	11*b*	June 4	32	− 72
	12*a*	May 13	96	
	12*b*	June 15	32	− 64
	13*a*	May 13	96	
	13*b*	June 26	48	− 24
	14*a*	May 13	48	
	14*b*	May 24	80	− 120
	15*a*	May 13	352	
	15*b*	June 4	96	− 264
	16*a*	May 13	368	
	16*b*	June 15	96	− 296
	17*a*	May 13	416	
	17*b*	June 26	112	− 288
	18*a*	May 13	384	
	18*b*	May 24	176	− 440
	19*a*	May 13	848	
	19*b*	June 4	160	− 656
	20*a*	May 13	784	
	20*b*	June 15	144	− 584
	21*a*	May 13	672	
	21*b*	June 26	80	− 632
	22*a*	May 13	752	

Size of Plots $\frac{1}{160}$ acre. Rate of Seeding 100 lb. per acre.

Date of harvest from 14th September to 17th October.

TABLE No. 6—*continued.*

Increase (+) or decrease (−) of Plots sown May 24th compared with plots sown, May 13th.	Increase (+) or decrease (−) of Plots sown June 4th compared with plots sown May 13th.
+ 152 lb. per acre.	− 64 lb. per acre.
− 104 „ „ „	− 72 „ „ „
− 120 „ „ „	−264 „ „ „
− 440 „ „ „	−656 „ „ „
Average − 128 ± 97 lb. per acre.	Average −264 ± 97 lb. per acre.

Increase (+) or decrease (−) of Plots sown June 15th compared with plots sown May 13th.	Increase (+) or decrease (−) of Plots sown June 26th compared with plots sown May 13th.
+ 232 lb. per acre.	− 136 lb. per acre.
− 64 „ „ „	− 24 „ „ „
− 292 „ „ „	− 288 „ „ „
− 584 „ „ „	− 632 „ „ „
Average − 177 ± 97 lb. per acre.	Average 270 ± 97 lb. per acre.

Root-mean-square difference between pairs of neighbouring controls:

= 194·4 lb. per acre.

Cost of cultivation in man-days per acre = 390.

TABLE No. 8.

RICE—DATE OF PLANTING EXPERIMENT.

Variety—Guiana Creole.

Block Plots.	Date of sowing.	Yields lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
C1 20*b*	May 31	576	
21*a*	May 17	768	+ 224
21*b*	May 31	512	
22*a*	May 24	1,088	+ 480
22*b*	May 31	704	
23*a*	June 7	...	− 544
23*b*	May 31	384	
24*a*	May 17	560	+ 240
24*b*	May 31	256	
25*a*	May 24	560	+ 344
25*b*	May 31	176	
26*a*	June 7	48	− 96
26*b*	May 31	112	
27*a*	May 17	528	+ 400
27*b*	May 31	144	
28*a*	May 24	400	− 272
28*b*	May 31	112	
29*a*	June 7	272	− 16
29*b*	May 31	464	
30*a*	May 17	1,008	+ 608
30*b*	May 31	336	
31*a*	May 24	720	+ 168
31*b*	May 31	768	
32*a*	June 7	496	− 232
32*b*	May 31	688	

Size of Plots $\frac{1}{16}$ acre. Rate of Seeding 100 lb.

Date of harvest, 9th November.

Increase (+) or decrease (−) of plots sown May 17th compared with plots sown May 31st.	Increase (+) or decrease (−) of plots sown May 24th compared with plots sown May 31st.	Increase (+) or decrease (−) of plots sown June 7th compared with plots sown May 31st.
+ 224 lb. per acre.	+ 480 lb. per acre.	− 96 lb. per acre.
+ 240 „ „ „	+ 344 „ „ „	− 16 „ „ „
+ 400 „ „ „	− 272 „ „ „	− 232 „ „ „
+ 608 „ „ „	+ 168 „ „ „	− 544 „ „ „
Average + 368 ± 102 lb. per acre.	Average + 180 ± 102 lb. per acre.	Average − 222 ± 102 lb. per acre.

Root—mean—square—difference between pairs of neighbouring controls: = 205·2 lb.

Cost of cultivation in man-days per acre = 238.

TABLE No. 9.

Rice Experiment.

Broadcast on Flat *v* Dibbled on Ridge *v* Transplanted to Ridge.

Variety—Guiana Creole.

Block Plots.	Treatment.	Yield lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
E1 9	Broadcast on Flat	240	
10	Dibbled on Ridge	168	− 104
11	Broadcast on Flat	304	
12	Transplant to Ridge	408	+ 136
13	Broadcast on Flat	240	
14	Dibbled on Ridge	-	− 288
15	Broadcast on Flat	336	
16	Transplant to Ridge	600	+ 16
17	Broadcast on Flat	832	
18	Dibbled on Bidge	392	− 508
19	Broadcast on Flat	968	
20	Transplant to Ridge	1,296	+ 340
21	Broadcast on Flat	944	
22	Dibbled on Ridge	336	− 384
23	Broadcast on Flat	496	
24	Transplant to Ridge	1,168	+ 124
25	Broadcast on Flat	1,592	

Size of plots $\frac{1}{8}$ acre—Rate of Broadcasting 100 lb. per acre.
Rate of Dibbling 16 „ „ „

Broadcasted and Dibbled 9th July.

Transplanted 16th August.

All harvested 15th November.

Increase (+) or decrease (−) of plots Dibbled on Ridge compared with plots Broadcasted on Flat.

− 104 lb. per acre.
− 288 „ „ „
− 508 „ „ „
− 384 „ „ „

Average − 321 ± 214 lb. per acre.

Increase (+) or decrease (−) of plots transplanted to Ridge compared with plots Broadcasted on Flat.

+ 136 lb. per acre.
+ 16 „ „ „
+ 340 „ „ „
+ 124 „ „ „

Average + 154 ± 214 lb. per acre.

Root-Mean-Square difference between pairs of neighbouring controls = 429·4 lb.

Cost of cultivation in man-days per acre = 125.

ANNUAL REPORT—YANDEV PLANTATION, BENUE PROVINCE, 1927.

BY

I. E. JAMES, B.SC.

Experiments in 1927 were for the most part concerned with investigations of the principal crops grown by the Munshis, the introduction of new varieties and the improvement of the existing Munshi rotation.

The following rotation is the one which is normally practised in Munshi country:—

First Year.—Yams interplanted with cotton, beans and minor crops.
Second Year.—Millet followed by Guinea corn.
Third Year.—Beniseed.
Fourth to Fifth Year.—Bush.

After the third year the land is allowed to go back to bush for several years until it has renewed its fertility and, consequently, a great deal of labour is expended annually in clearing bush land, besides which this system of shifting cultivation is extremely wasteful. With a view to an attempt to introduce permanent cultivation forty acres of land were set apart on the plantation for the practice of a four years' rotation, which it is hoped will appeal to the Munshis, and so replace their present method of shifting cultivation. The tsetse fly is present in the country and only a few dwarf cattle are kept, artificial manures are too expensive, so that green manuring will be an essential part of any such rotation. The possibilities of various green manures are being investigated, but comparative results will not be available until next year. Mucuna was found to give an excellent bulk of foliage, and unlike its habit at Zaria, it produces bacterial nodules on its roots and it is probable that this crop will prove satisfactory.

In rotations, difficulty will probably arise with regard to imperata grass. This grass obtains a firm hold of the land after two to three years' cropping and is very difficult to eradicate. Allowing the land to go back to bush has the effect of keeping it in check, and it is anticipated that a cover crop such as mucuna will have a similar effect. The rotation which is being experimented with is as follows:—

First Year.—Yams interplanted with beans.
Second Year.—Millet followed by guinea corn.
Third Year.—Green manure followed by cotton.
Fourth Year.—Beniseed followed by green manure.

This may prove to be of too exhausting a nature, so that next year the following rotation will also be tested :—

First Year.—Yam interplanted with cotton.
Second Year.—Millet followed by Guinea corn.
Third Year.—Beniseed followed by green manure.
Fourth Year.—Green manure.

The yam constitutes the principal food crop of the Munshis. During recent years yam beetle infestations have occurred and have caused a great deal of destruction. Experiments are being carried out to try and find methods of eradicating or lessening the intensity of this pest such as time of planting, staking, depth of planting and the introduction of new varieties.

According to the Munshi rotation, Guinea corn is planted after the millet has been harvested. This does not allow sufficient time for the Guinea corn to mature before the dry season arrives and consequently very poor yields are obtained. Tests on the time of planting Guinea corn through millet, thus allowing the Guinea corn ample time to mature, were carried out on the station, but owing to the absence of suitable land, bush land was used and the resulting yields of both millet and Guinea corn were too low to give definite information on this point. This will be tested out this season.

Yams—Time of Planting Test.

(*See* Table No. 1.)

The object of this experiment was to determine the amount of damage caused to yams, planted at different times, by the yam beetle. Unfortunately, owing to famine conditions in the Province, it was found impossible to obtain sufficient seed in time to plant more than two plots of early yams. These plots were planted on the 26th April, 1927, and a further seven plots planted on the 15th June, 1927. Early planted yams were fairly heavily attacked by the yam beetle, while the attack on the June planted was negligible.

% of Early Yams attacked by Beetle	...	...	23·76
% of Late Yams attacked by Beetle	...	...	·38

The indications are that, notwithstanding the heavy beetle attacked. A few of the yams were wholly destroyed while the majority were slightly damaged, although not rendered unfit for consumption.

Although the early planted suffered more severely yet in actual yield they were far superior.

Yield of 2 plots planted 26th April, 1927, 12 sq. ft. per plant, 11,992 lb. per acre.
Yield of 3 plots planted 15th June, 1927, 12 sq. ft. per plant, 6,017 lb. per acre.
Yield of 4 plots planted 15th June, 1927, 12 sq. ft. per plant, 3,730½ lb. per acre.

The indications are that, notwithstanding the heavy beetle attack on early planted yams, planting in June entails too great a decrease in yield to constitute an economic remedy. Compared to neighbouring native farms, the beetle infestation on our plantation was slight. It is possible that next year a severe infestation will be experienced, so that a more definite result will be obtained from a time of planting test.

Yams—Staking Test.

(*See* Table No. 2.)

	Yield of Yams in lb. per acre.	Odds that difference is significant.
Average of 5 plots staked	7,431	—
Average difference of 4 plots not staked	−701 ± 291	150 : 1

There is a distinct indication that staking will result in an increased yield, but owing to the scarcity and difficulty of obtaining suitable stakes, it was found that the cost of staking more than balanced the increased value of yams obtained. The success of staking in Munshi country will depend on the facility with which stakes can be obtained and for how many years a set of stakes will last, as the actual cost of staking is not an expensive item. This test was carried out, not only to compare yields but also to determine the effect of staking on beetle infestation, it is believed that the beetle likes cool soil conditions, and by staking it was thought that the vines would be removed from the soil surface, and the exposure of vines would be removed from the soil surface, and the exposure of the soil to the sun would discourage the beetle. The beetle infestation was, however, too slight to give any indications.

Yams—Depth of Planting.

(*See* Table No. 3.)

	Yield of Yams in lb. per acre.	Odds that difference is significant.
Average yield 5 plots at 4″ depth ...	7,773	—
Average difference 4 plots at 9″ depth	−1,244 ± 401	740 : 1

The soil on these plots consisted of about one foot of sandy loam on the surface with a red gravel sand subsoil. As a result of deep planting, the tubers soon reached the non-fertile subsoil and growth was checked, whereas the shallow planted had a greater depth of good soil. This soil condition is typical of a great part of Munshi country. It is possible that deep planting will lessen the intensity of the beetle attack, but the infestation this year has been so slight on the plantation that definite indications were not obtained.

Benniseed—Ridges *versus* Broadcast (Native Method).

(*See* Table No. 4.)

	Yield of Benniseed in lb. per acre.	Odds that difference is significant.
Average yield 10 plots Ridged	103	—
Average difference 9 plots Broadcast	−16 ± 83	160 : 1

According to the custom of the country benniseed is broadcasted on land which has received two years' cropping. Such land was not available on the plantation owing to this being the first year of experimentation, and bush land had to be utilised. It has been shown by this and other tests that bush land is unsuitable for early planted benniseed—and accounts for the low yields obtained. The benniseed sown broadcast became choked by weeds and it was not possible to carry out any weeding as was done to that sown on ridges.

Ground Nuts and Benniseed.

Comparative Residual Value and Costings.

(*See* Table No. 5.)

Average yield 10 plots Groundnuts	1,995 lb. per acre.
Average yield 9 plots Benniseed	376 lb. per acre.

Second year land, having cotton as first year crop, was used, and both crops planted in late April. The weight of ground nuts is expressed as dried undecorticated. The object of this experiment was to compare the costings of each crop and their residual effect on the soil. This latter will be determined by a test crop of gero next year. Both crops gave remarkably good yields, that for benniseed being greatly superior to the yield usually obtained on native farms. Ground nuts are not grown on a large scale by the Munshis so that no comparison of yields is possible. Harvesting costs are very heavy for both crops but, expressed in monetary returns per man day, the ground nuts are distinctly more profitable, even at the ridiculously low price of £4 and £5 per ton.

	Costs in M.D.P.A.	Average yield per acre.	Cost of crop M.D.P. lb.	Market Value.	Calcd. return per acre.
G. Nuts ...	154	1,995	·08	·50d.	£4 3s. 1½
Benniseed ...	104	376	·21	·96d.	£1 10s. 1

	Monetary return per man day.	Condition of crop.
G. Nuts	6·48d.	Undecorticated
Benniseed	3·47d.	Seed

The possibilities of ground nuts as a money crop for the Munshis will be further investigated next year and, if the high yields are repeated, this crop will be considered as a possible substitute for benniseed.

Maize—Variety Test.

Munshi *v.* Lagos White.

(*See* Table No. 6.)

	Yield of Maize in lb. of dried cobs.	Odds that difference is significant.
Average yield 5 plots Munshi	1,239	—
Average difference 4 plots Lagos White	−389·5 ± 80	33,000 : 1

The Munshi and Lagos white maize were planted in early May. The latter made excellent growth until the short drought occurred in July, when the plants were burnt up and only a very small yield was harvested in late August. The Munshi variety is early maturing and was ready for harvesting when the drought occurred. This test will be repeated next year with planting carried out in middle April.

Only a small area of maize is grown by the Munshis, who consume it as soon as ripe, storing sufficient for next year's seed. Early maturity is an essential characteristic, for maize is the first food crop to be produced during the wet season, and during recent years has been depended upon to break the famine period until the millet crop is ready. The local variety would benefit greatly from selection, as a good quality maize would probably be produced, which would retain its early maturing character.

Green Manures—Residual Value Tests.

Pigeon peas did remarkably well on the plantation last season, producing a good supply of food during the dry season. The above test was set up to compare the effect of pigeon peas occupying the land for a year with (1) mucuna beans followed by an edible bean (cowpeas), and (2) mucuna beans alone. The pigeon peas in this test were badly attacked by a coleoptera pest, which destroyed the young flower buds, and they had to be turned in on the 21st January, 1928 as manure without any yield of peas being harvested. Mucuna did exceptionally well, producing a very heavy bulk of foliage. The cowpeas were planted after turned-in mucuna on five test plots on the 9th August, 1927, which did not give them time to produce a good yield of beans.

The above plots will be planted next season with millet and Guinea corn as test crops, and continued for a few years as a two years rotation.

Cotton Variety Test.

(*See* Table No. 7.)

	Yield of seed cotton lb. per acre.	Odds that difference is significant.
Average yield of 10 plots Munshi ...	155·4	—
Average difference of 5 plots Allen ...	−59·4 ± 9·89	∞ : 1
Average difference of 4 plots Ishan A. ...	−8·75 ± 9·89	4 : 1

The three varieties were subjected to optimum times of planting and spacing as determined at the Agricultural Station, Ibadan. Cotton stainers were numerous on all varieties, first infecting the Allen and then the others. Heavy shedding of the earliest formed bolls occurred, but the amount of stained lint was less than last year. The Munshi and Ishan A. suffered a severe setback owing to an intense attack of bacterium malvacearum (angular leaf spot). One hundred *per cent.* of the plants were affected and the earlier formed bolls and buds were completely shed. Secondary growth and the harvesting of the seed cotton was consequently very late, the largest picking being obtained at the end of March. Leaf roll was present on the Allen but did not cause much damage.

Conditions in this Province, from the point of view of cotton, resemble those of the south rather than the north, and success in cotton growing would appear to depend on the improvement of the local Munshi variety or the introducing of improved Ishan (Ishan A.) rather than the introduction of Allen cotton.

Cotton in all Munshi districts this year proved a failure owing principally to the severe attack of angular leaf spot. The Munshis have not as yet, discovered the best time of planting and treatment of this crop.

I. E. JAMES,
Superintendent of Agriculture.

TABLE No. 1.

YAMS—TIME OF PLANTING.

No. of Block.	Date of Planting	Spacing.	Yield of Yams in lb. acre.
Block A2.			
Plot 1	15.6.27	12 square feet plant	6,570
2	26.4.27	do.	11,166
3	15.6.27	do.	5,972
4	15.6.27	do.	5,510
5	15.6.27	18 square feet plant	4,046
6	26.4.27	12 square feet plant	12,818
7	15.6.27	18 square feet plant	3,670
8	15.6.27	do.	3,704
9	15.6.27	do.	3,502

INTENSITY OF DAMAGE CAUSED BY BEETLE (H. CLAUDIUS KLUG)

No. of Plot.	Total No. harvested.	No. badly damaged.	No. slighly damaged.	Total No. damaged %
1	856	0	4	·47
2	1,250	130	224	28·32
3	662	0	3	·45
4	733	1	4	·68
5	510	0	0	·00
6	1,010	36	147	18·12
7	516	0	4	·78
8	491	0	0	·00
9	443	0	0	·00

Average % of Yams planted 26.4.27 damaged 23·76

Average % of Yams planted 15.6.27 damaged ·38

TABLE No. 2.

YAMS—STAKING *versus* NON-STAKING.

No. of Plot.	Treatment.	Yield of Yams in lb. acre.	Increase (+) or Decrease (−) compared with mean of adjacent controls.
Block A2			
Plot 11	Staked	8,144	
12	Non-Staked	6,868	− 881
13	Staked	7,351	
14	Non-Staked	7,172	+ 56
15	Staked	6,878	
16	Non-Staked	6,704	− 255
17	Staked	7,040	
18	Non-Staked	5,660	−1,725
19	Staked	7,730	
20	Staked	6,812	Non-experimental.

Each Plot $\frac{1}{5}$ acre. Ridges 6′ apart. Single sets 2′ apart.

Sown 15th June, 1927, Harvested 1st January, 1928.

Average decrease of Non-Staked Plots compared with Staked Plots 701±291

Root-Mean-Square-Difference between neighbouring control Plots 583·9 lb. per acre.

% NO. OF YAMS DAMAGED BY BEETLE.

No. of Plot.	% Damaged.		
11	5·11		
12	·00		
13	2·71		
14	·00		
15	1·61	Average Staked	3·00%
16	1·01	Average Non-Staked	·25%
17	2·01		
18	·00		
19	2·43		
20	4·12		

TABLE No. 3.

YAMS—DEPTH OF PLANTING, 4″ *versus* 9″.

No. of Plot.	Depth Planted.	Yield of Yams in lb./acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block A3			
Plot 1	4 inches	6,602	
2	9 ,,	6,920	− 475
3	4 ,,	8,188	
4	9 ,,	6,792	− 1,374
5	4 ,,	8,090	
6	9 ,,	6,884	− 1,122
7	4 ,,	7,922	
8	9 ,,	5,960	− 2,033
9	4 ,,	8,064	
10	4 ,,	7,292	Non-experimental.

Each plot $\frac{1}{4}$ acre. Ridges 6′ apart. Single Sets 3′ apart.

Sown 10th June, 1927. Harvested 7th January, 1928.

Average difference of 9″ Depth compared with 4″ Depth 1,244 ± 401.

Root-Mean-Square-Difference between neighbouring control plots 802·09 lb. per acre.

% No. OF YAMS DAMAGED BY BEETLE.

No. of Plot.	% Damaged.	
1	·61	
2	2·01	
3	2·58	
4	·83	
5	1·08	Average of 4″ 1·11%
6	·61	Average of 9″ ·86%
7	·50	
8	·00	
9	1·75	
10	·16	

TABLE No. 4.

BENNISEED—RIDGES *versus* BROADCAST.

No. of Plot.	Cultivation.	Yield of Seed in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block B2.			
Plot 1	Ridges	102	
2	Broadcast ...	138	+ 31
3	Ridges	112	
4	Broadcast ...	130	+ 20
5	Ridges	108	
6	Broadcast ...	112	+ 6
7	Ridges	104	
8	Broadcast ...	132	+ 22
9	Ridges	116	
10	Broadcast ...	72	− 40
11	Ridges	108	
12	Broadcast ...	58	− 38
13	Bridges	84	
14	Broadcast ...	62	− 15
15	Ridges	70	
16	Broadcast ...	34	− 55
17	Ridges	108	
18	Broadcast ...	38	− 77
19	Ridges	122	
20	Ridges	52	Non-experimental.

Each Plot $\frac{1}{4}$ acre. Ridges 6′ apart. Three rows 1′ 6″ apart Seed 20 lb. per acre. Broadcast. Seed 13 lb. per acre.

Planted, 5th May, 1927. Harvested, 25th August, 1927.

Average decrease of Broadcast compared with Ridges $16 \pm 5{\cdot}83$.

Root- mean- Square—Difference between neighbouring control plots 17·49 lb. per acre.

TABLE No. 5.

GROUNDNUTS *versus* BENNISEED. RESIDUAL VALUE AND COSTINGS.

No. of Plot.	Crop.	Yield in lb. per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block A1.			
Plot 1	Groundnuts ...	2,234	
2	Benniseed ...	312	− 1,819
3	Groundnuts ...	2,028	
4	Benniseed ...	400	− 1,577
5	Groundnuts ...	1,926	
6	Benniseed ...	394	− 1,521
7	Groundnuts ...	1,904	
8	Benniseed ...	394	− 1,546
9	Groundnuts ...	1,976	
10	Benniseed ...	420	− 1,545
11	Groundnuts ...	1,954	
12	Benniseed ...	378	− 1,576
13	Groundnuts ...	1,954	
14	Benniseed ...	358	− 1,487
15	Groundnuts ...	1,736	
16	Benniseed ...	424	− 1,512
17	Groundnuts ...	2,136	
18	Benniseed ...	308	− 1,810
19	Groundnuts . .	2,100	
20	Groundnuts ...	2,136 Non-experimental	

Each plot $\frac{1}{4}$ acre. All on 3 feet ridges.
Groundnuts—$1\frac{1}{2}'$ apart, two rows, two plants/stand.
Benniseed —$1'$ apart, two rows, three plants/stand.

Planted 25th April, 1927. Harvested—Groundnuts, 25th August, 1927.
Benniseed, 8th August, 1927.

Average decrease of Benniseed compared to Groundnuts 1,599±57·5.

Root—Mean—Square—Difference between neighbouring control plots.
172·5 lb. per acre.

TABLE No. 6.

MAIZE—VARIETY TEST. MUNSHI *versus* LAGOS WHITE.

No. of Plot.	Variety.	Yield in lb. of dried cobs per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block B8.			
Plot 1	Munshi	1,476	
2	Lagos White ...	972	− 379
3	Munshi	1,226	
4	Lagos White ...	836	− 429
5	Munshi	1,304	
6	Lagos White ..	734	− 485
7	Munshi	1,134	
8	Lagos White ...	830	− 265
9	Munshi	1,056	
10	Munshi	Non-experimental.	

Each plot $\frac{1}{4}$ acre. All on 6′ ridges. 2′ apart, two rows, two plants/stand.
Planted, 5th May, 1927. Harvested. Munshi, 21st July, 1927.
Lagos White, 21st August, 1928.

Average decrease of Lagos White compared to Munshi 389·5±80·45.

Root - Mean—Square—Difference between neighbouring controls 160·91.

TABLE No. 7.

COTTON—VARIETY TEST. MUNSHI *v* ALLEN *v* ISHAN A.

No. of Plots.	Variety.	Yield in lb. of Seed Cotton per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block C 4			
Plot 1	Munshi	173	
2	Allen	85	− 67
3	Munshi	128	
4	Ishan A	146	− 9
5	Munshi	182	
6	Allen	112	− 64
7	Munshi	170	
8	Ishan A	147	− 25
9	Munshi	174	
10	Allen	115	− 48
11	Munshi	152	
12	Ishan A	140	+ 4
13	Munshi	120	
14	Allen	91	− 42
15	Munshi	147	
16	Ishan A	150	− 5
17	Munshi	163	
18	Allen	78	− 76
19	Munshi	145	
20	Munshi	189 Non-	experimental.

Each plot ¼ acre. All on 6′ ridges. Munshi 2 feet apart on ridges staggered.

Allen 1 „ „ „ „ „

Ishan 2 „ „ „ „ „

Planted Munshi 1st July, 1927.

„ Ishan A 1st July, 1927. Harvested 13th December, 1927 to 19th March, 1928.

„ Allen 15th July, 1927.

Average decrease of Allen compared to Munshi 59·4 ± 9·89.

Average decrease of Ishan A compared to Munshi 8·75 ± 9·89.

Root—Mean—Square—Difference between neighbouring controls. 29·66.

TABLE No. 8.

Cost of cultivation of main crops 1927–28 season in Man-days per acre.

Crop.	Preparation.	Sowing.	After Cultivation.	Harvest.	Miscellaneous including guarding.	Total Man-days per acre.
Yams	41·5	13·2	28·2	28·9	·7	112·5
Benniseed	30·6	12·1	5·1	22·1	1·8	71·7
Groundnuts	36·0	13·7	4·4	33·7	6·3	94·1
Maize	39 6	7·2	5·6	13·2	9·6	75·2
Bambara Groundnuts.	5·0	4·0	4·0	40·0	—	53·0
Millet and Guinea-corn.	37·1	12·6	16·5	15·75	11·05	93·0
Cotton	35·4	5·9	16·9	6·1	—	64·3

Note—1. Bambara Groundnuts were grown on old Cotton ridges—not split.

TABLE No. 9.

Comparison of cost of Production and Revenue from main Crops 1927–28 season.

Crop.	Cost in man-days per acre.	Average yield per acre in lb.	Cost of crop in man days per lb.	Assumed market value per lb. in same condition.	Calculated return per acre.
					£ s. d.
Yam	112·5	6,390	·018	·125d.	3 6 6
Benniseed	71·7	175	·41	·96	0 14 0
Groundnuts	94·1	1,208	·08	·33	1 13 7
Maize	75·2	1,002	·07	·30	1 5 1
Bambara Groundnuts ...	53·0	1,275	·04	·66	3 10 10
Millet and Guineacorn ...	93·0	467·55	·20	·44	0 17 4
Cotton	64·3	114·2	·56	1·65	0 15 8

Crop	Monetary return per man-day.	Condition of Crop.
Yam	7·1d.	Tubers as stored.
Benniseed	2·34d.	Seed.
Groundnuts	4·28d.	Undecorticated.
Maize	4·00d.	Dried Cobs.
Bambara Groundnuts	16·04d.	Undecorticated.
Millet and Guineacorn	2·23d.	Threshed.
Cotton	2·93d.	Seed Cotton.

Note—1. Labour pay on Plantation, 6d. per diem.

TABLE No. 10.

RAINFALL RECORD—YANDEV MAKURDI, 1927.

Month.	Inches of Rainfall recorded.	No. of days in which rain fell.
January	·00	0
February	·58	1
March	·36	1
April	4·14	8
May	10·10	12
June	5·79	15
July	4·28	18
August	9·63	20
September	7·99	16
October	9·67	18
November	1·11	1
December	·54	1
Totals	54·19	111

ANNUAL REPORT—MAIGANA SEED FARM, 1927.

BY

A. H. S. VIGO, SENIOR OVERSEER.

The total rainfall for the year, 47 :83 inches, was well up to the average, but the early part of the season was rather drier than usual, with the result that cultural operations and planting were somewhat hindered.

The rains extended well into October, and the onset of the "harmattan" was gradual, so that on the whole 1927 was climatically a very favourable year.

The system of manuring, by kraaling cattle over the land during the dry season, was again adopted with success, but green manuring also gave very good results.

COTTON.

The following strains of Allen cotton were multiplied during the season :—

Strain No. 5/1925, forty-one acres, main crop.
Selection Progenies of 1926 (twenty-six strains) twelve acres.
Bulked selections of 1927 (300 plants) three acres.
Individual plant selections of 1927 (thirty plants) one acre.

The average yield of the whole crop, from fifty-six acres, was 523 lb. of seed cotton per acre, which constitutes a record yield for the plantation. The average yield for the previous season was 272 lb. per acre.

The greatest yield from any one plot was 804 lb. per acre from a half acre plot of strain M. 102/1926.

Good yields were also recorded from selected native farms. The yields and other relevant data of the various strains are given in Table No. 2.

COTTON DISINFECTION EXPERIMENT.

(*See* TABLE NO. 3.)

	Yield per acre of seed cotton in lb.	Odds that difference is significant.
Acreage yield 5 plots sown with untreated seed	245	—
Average difference 4 plots sown with treated seed	+ 24 ± 33·8	3 : 1

This experiment was a duplicate of one carried out at Samaru, the object being to see the effect of disinfecting the seed by treating it with concentrated sulphuric acid before sowing.

The experiment was laid out in fairly new and even land. The whole block was surrounded by a screen of guinea corn thirty-three feet wide, and there was also a plot of guinea corn between each plot of cotton. Cultivation was done by separate gangs. As cotton in Nigeria is normally very free from disease and as the season was a particularly favourable one in this respect a big difference between the yields from the treated and untreated plots could hardly be expected. The actual increase from the treated plots of 24 ± 33.8 lb. per acre is negligible.

There was one very noticeable effect of disinfection, namely, that the germination of the treated seed was much quicker than that of the untreated seed and a better stand of plants resulted from it.

Manurial Experiment.

(*See* Table No. 4.)

The experiment on Block A. which was started in 1925 to compare the effect of kraaling followed by early green manure as against early green manure alone was continued for the third season. The mucuna on the plots which had been kraaled grew faster than on the unmanured plots and consequently a bigger growth was available for turning in as green manure. As compared with the early green manure alone, the manured plots followed by green manure gave an increased yield of 28.5 *per cent.*, and over the three years during which the experiment has been going the increased yield has amounted to 26.6 *per cent.*

Early green manure as a preparation for cotton has not been a success at Samaru as the short growing period does not allow the mucuna to make a sufficiently heavy growth, but these results indicate that it may be very useful as a supplement to a small quantity of kraaled manure, when the quantity of the latter available is limited.

Seed Distribution.

Thirteen tons of improved seed were distributed to 1,093 farmers early in the season, and sufficed for the planting of approximately 1,948 acres. Food shortage among the farmers interfered with preparation of the land and a good deal of cotton was unavoidably planted late. The resultant crop which is being purchased by the British Cotton Growing Association at Awai will hardly

exceed seventy-five tons. It is notable that quite ninety-nine *per cent.* of the purchased crop is Grade I cotton.

Guinea Corn and Millet.

(*See* Table No. 5.)

" Bulrush " millet (Hausa gero) was interplanted with the guinea corn, which consisted of five acres " kaura " and five acres farafara on Block " D " half acre plots of " kaura " and " farafara " selections were grown on Block " H ". Afair crop of " millet " was harvested. The guinea corn yields were up to average. Half an acre of kaura selections yielded at the rate of 2,414 lb. per acre.

" Cowpeas " and Lima Beans.

Both varieties were interplanted with guinea corn. The latter, grown for the first time this season, gives promise of becoming the more reliable bean for interplanting with guinea corn. A greater amount of seed was produced than in the case of " cowpeas."

Cover Crop.

Ten acres of " mucuna " were grown on Block " E." for providing seed for raising green manuring crops. 205 pounds of clean seed were obtained per acre. The haulms were subsequently fed to Fulani cattle brought on to the block for kraaling. Block " E." alternates with Block " D." in the growing of mucuna and guinea corn.

Miscellaneous Crops.

Small plots of tannia and eddo, guinea and elephant grasses, kerstingiella, and West Indian canes of the varieties B. 208 and B. 6,308 were maintained for supplying other stations.

Ginger.

A quarter of an acre plot was grown for observation. The crop made good progress and has produced a good weight of tubers.

A. H. S. VIGO,
Senior Overseer.

TABLE No. 1.

Rainfall Record Maigana.

Month.	Inches of rain recorded 1927.	No. of days on which rain fell.	Rainfall in 1926.	No. of days.
January ...	...	...	...	...
February ...	...	...	...	...
March ...	...	...	...	...
April	2·55	5	·69	2
May	4·33	9	4·61	11
June	4·25	12	8·57	12
July	5·56	11	10·08	19
August ...	18·45	23	15·22	22
September ...	9·58	18	5·56	12
October ...	3·11	9	·53	1
November ...	...	...	...	...
December ...	...	...	...	...
Totals ...	47·83″	87	45·26″	79

TABLE No. 2.

Yields of Selected Strains of Allen Cotton.

Block.	Plot.	Variety.	Acreage.	Treatment.	Yield per acre in lb. Seed Cotton.	Ginning % lint.	Average lint length.
B.	1	Allen No. 5/1925.	5	300 cattle nights per acre and early mucuna	525	29·5	34 M.M
B.	2	,,	2½	do.	586	,,	34 M.M 6′ ridges & 2 plants on the ridge.
B.	3	,,	2½	do.	538·4	,,	34 M.M 4′ ridges & 1 plant on the ridge.
C.	—	,,	10	do.	582·4	,,	34 M.M
F.	—	,,	10	do.	456·2	,,	,,

TABLE No. 2.—*continued.*

Block.	Plot.	Selection No.	Acreage.	Treatment.	Yield per acre in lb Seed Cotton.	Ginning % lint.	Average lint length. in m.m.
G.	1	p.1.	$\frac{15}{33}$ ac.	1,000 Cattle nights per acre kraaling.	501·6	28·4	34·6
G.	2	B.M.14	$\frac{14}{33}$ „	„	577·5	29·6	36·7
G.	3	p.11	„ „	„	586·9	29·7	35·9
G.	4	M.156	„ „	„	723·6	28·2	36·9
G.	5	M.179	„ „	„	700	28·2	34·1
G.	6	D.84	„ „	„	641	27·9	31·7
G.	7	M.112	„ „	„	565·7	28·0	35·0
G.	8	A.27	„ „	„	590	28·7	34·0
G.	9	N1.147	„ „	„	590	25·0	36·3
G.	10	N1.19	„ „	„	702·4	28·0	33·0
G.	11	BM.7	„ „	„	558·6	29·6	34·5
G.	12	M.127	$\frac{15}{33}$ „	„	501·6	28·0	33·3
G.	13	M.157	$\frac{14}{33}$ „	„	443	28·3	33·0 (Water logged plot).
G.	14	M.121	„ „	„	440·9	27·0	34·0 (Water logged plot).
G.	15	M.4	„ „	„	735·4	30·9	35·6
G.	16	M.138	„ „	„	664·7	29·6	32·3
G.	17	M.55	„ „	„	749·9	28·4	31·8
G.	18	M.193	„ „	„	749·9	28·1	32·0
G.	19	M.40	„ „	„	751·9	28·3	32·0
G.	20	M.153	„ „	„	629·4	29·4	36·0
G.	21	M.158	„ „	„	523·3	28·4	33·7
G.	22	M.172	„ „	„	381·9	27·3	32·0 (Water logged plot).
H.	2	A·19	$\frac{1}{2}$ „	300 cattle nights per acre.	616·0	28·6	33·0
H.	2	A.40	„ „	„	580·0	28·6	37·5
H.	3	M.39	„ „	„	800·0	27·8	34·8
H.	4–5	M.1	2 „	„	602·5	29·5	35·4
H.	7	M.2	1 „	„	459·0	27·5	33·6 (Water logged plot).
H.	8	A.102	$\frac{1}{2}$ „ 15 acs.	„	804·0	27·9	35

1. Cost of cultivation in man-days per acre = 74.
2. Date of planting Mucuna 21st January—16th February.
3. Date of digging in Mucuna 17th–30th June.
4. Date of planting cotton 4th–10th July.
5. Date of harvesting cotton 21st December–17th February.
6. Average yield per acre main crop cotton from 41 acres = 498·0 lb.
7. Average yield per acre selection cotton progenies 15 acres = 613·0 lb.
8. M.2—Bulked selections of various strains made in 1927.
9. M.1—Bulked selections of strains 5/1925 made in 1927.

TABLE No. 3.

Cotton Seed Disinfection.

No. of plot.	Treatment.	Yields of Cotton per acre lb.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block K.			
1	Undisinfected	152	
2	Disinfected	176	− 40
3	Undisinfected	280	
4	Disinfected	280	− 4
5	Undisinfected	288	
6	Disinfected	352	+ 72
7	Undisinfected	272	
8	Disinfected	320	+ 68
9	Undisinfected	232	

Increase (+) or decrease (−) of disinfected plots compared with undisinfected plots.

− 40
− 4
+ 72
+ 68

Average +24 ± 33·8 lb.

Root–mean–square–difference = 67·6 lb. per acre.

Average yield per acre of control plots 245 lb. per acre.

Size of plots $\frac{1}{8}$ acre.

Cotton sown 23rd July, 1927. Harvested 7th [illegible] 1928.

Ridges 4′ apart.

Table No. 4.

Early Green Manure experiment.

Block.	Plot.	Variety.	Acreage.	Treatment.	Yield per acre in lb. Seed Cotton.	Ginning. % Lint.	Average Lint. length M. M.
A	1	Allen No. 5/1925	2½	300 Cattle nights per acre kraaling and early mucuna	485·6	29·5%	34 M.M.
	2	„	2½	Mucuna alone	371·6	„	„
	4	„	2½	300 Cattle nights per acre kraaling and early mucuna	412·0	„	„
	3	„	2½	Mucuna alone	326·8	„	„

Average yield 2 plots cotton treated with "kraaled" manure and Mucuna = 448·8 per acre.
Average yield 2 plots cotton treated with "Mucuna" alone = 349·25 per acre.
Difference Mucuna and Manure plots over Mucuna alone plots = 99·55 per acre.
Average difference over three years 77·7 lb. per acre = 26·6% approximately.

TABLE No. 5.

Guineacorn and Millet—Main Crop.

Block.	Plots.	Variety.	Acreage.	Treatment.	Yield per acre unthreshed in lb.	Remarks.
D	—	Millet	10 acres	Mucuna folded kraaling at 300 C.N. *p.a.*	760·0	Interplanted in Guineacorn.
D	—	"Kaura"	5 „	do.	1,355·6	Planted from Bulk selections 1926.
D	—	"Farafara"	5 „	do.	1,212·6	do.
H	10	"Kaura"	½ „	300 cattle nights per acre kraaling	2,414·0	Planted from individual selections 1926.
H	6	"Farafara"	½ „	do.	1,458·0	do.

(1) Cost of cultivation of "Millet" in man-days per acre = 28.
(2) „ „ „ "Guineacorn" in man-days per acre = 67.
(3) Date of planting millet, 29th April 1927. Guineacorn, 16th May.
„ harvesting millet = 29th July–1st August 1927. Guineacorn, 22nd–30th November, 1927.